Discharge Pathways and Sources of Contaminants

We were unable to identify groundwater discharge pathways or information about sources of contamination.

Management Practices

We were unable to find information about how management practices affect groundwater quality.

Assessment of Data Adequacy and Need for Added Data

We were unable to identify groundwater quality data in this basin.

San Joaquin Valley Groundwater Basin—Introduction

Organization and Elements

The San Joaquin Valley Groundwater Basin lies within the San Joaquin River and Tulare Lake Hydrologic Regions (HRs). The northern portion of the basin is within the San Joaquin River HR and consists of nine subbasins. These subbasins are the Cosumnes, Eastern San Joaquin, Tracy, Modesto, Turlock, Merced, Delta-Mendota, Chowchilla, and Madera (Figure 4-3). The southern portion of the basin lies in the Tulare Lake HR and consists of seven groundwater subbasins. These subbasins are the Kings, Westside, Kaweah, Tulare Lake, Pleasant Valley, Tule, and Kern (Figure 4-4). These subbasins are described in detail below.

The San Joaquin River HR portion of the basin covers approximately 3.73 million acres with the Tulare Lake HR portion of the basin covering approximately 5.15 million acres. Groundwater is extensively used in the San Joaquin Valley Groundwater Basin by agricultural and urban entities and accounts for approximately 48% of the groundwater used in the State (DWR 2003).

Information presented includes general descriptions on information sources, BMPs, overview of agricultural chemical impacts to groundwater, and data adequacy. Physiography, major sources of groundwater recharge, land uses, water quality, and contaminant sources and discharge pathways are presented by subbasin following the general discussions.

General Sources of Information

The hydrogeologic descriptions of the San Joaquin Valley Groundwater Basin and associated subbasins are taken from the DWR Bulletin 118 (DWR 2003). Water quality data were obtained from the DPR (Schuette 2003), Bulletin 118, and other published documents. The DPR data is county specific, not specific to the individual subbasins. Land use data were obtained from DWR and is referenced on the land use maps. Regulatory and groundwater management information were obtained from various DWR publications as well as from various county websites. Population information was obtained from county and or individual city web sites. Information regarding groundwater ordinances and regulation were obtained from Bulletin 118 (DWR 2003) and contacting individual counties. A reference section is presented at the end of this report detailing information sources.

Overview of Agricultural Chemical Impacts to Groundwater

This section presents a discussion of data that are on a more regional scale than any one subbasin and are intended to provide an overview of agricultural chemical impacts to groundwater in the San Joaquin Valley Groundwater Basin.

The National Water Quality Assessment (NAQWA) for the San Joaquin Valley Groundwater Basin concluded that groundwater within the eastern portion of the San Joaquin Valley that supplies drinking water to the majority of the population has been degraded by fertilizers and pesticides (Dubrovsky et al. 1998). This report concluded that nitrate concentrations frequently exceeded drinking water standards while pesticides, with the exception of DBCP, rarely exceeded drinking water standards. Their specific conclusions are listed below.

- Nitrate concentrations in groundwater in the eastern San Joaquin Valley exceeded drinking water standards in approximately 25% of domestic water supply wells sampled.
- Nitrate concentrations in shallow groundwater were related to agricultural land use settings. Detected concentrations were related to fertilizer application, physical characteristics of the sediment, and groundwater biochemical processes and varied among different agricultural land-use settings.
- Since the 1950s, nitrate concentrations in groundwater have increased. During the same period, nitrogen fertilizer applications have increased from 114 to 745 million pounds per year.
- Pesticides were detected in approximately 67% of the groundwater samples collected from domestic water supply wells. However, most concentrations were less than 0.1 micrograms per liter (µg/L).

- Detected pesticide concentrations generally did not increase between 1986 and 1995.

The occurrence of pesticides and nitrates in groundwater were studied in three agricultural land-use settings in the eastern San Joaquin Valley (Burrow et al. 1998). The concentration and occurrence of nitrates and pesticides in groundwater was related to differences in chemical applications and physical and biochemical processes at each of the three locations. Significant conclusions of the study are listed below.

- Groundwater beneath vineyard and almond land-use settings is more vulnerable to non-point source contamination than groundwater beneath the corn, alfalfa, and vegetable (row crop) land-use setting on the lower (more distal) part of the alluvial fan.
- Nitrate concentrations in groundwater beneath almond orchards are typically higher than nitrate concentrations in groundwater beneath vineyards because nitrate fertilizer application rates are typically higher in almonds than vineyards.
- Row crops on fine-grained sediments and low dissolved oxygen concentrations reflect processes that result in slow infiltration rates and longer groundwater residence times. Intermediate nitrate concentrations in groundwater are the result of these characteristics combined with typically high application rates.
- Nitrate concentrations in groundwater have increased with time.
- 23 different pesticides were detected in 41 of 60 groundwater samples collected.
- At least one pesticide was detected in 80% of the groundwater samples collected from the vineyard land-use setting, 70% of the groundwater samples collected from the almond land-use setting, and 55% of the groundwater samples collected from the row crop land-use setting.
- Simazine was the most commonly detected pesticide. Simazine was detected in 50% of the groundwater samples from the vineyard land-use setting, 30% of the groundwater samples from the almond and row crop land-use setting,
- The occurrence of simazine, diuron, and DBCP was consistent with recent and historical use of these pesticides.
- The occurrence of atrazine was not directly related to crop use and may be related to applications on rights-of-ways.

Domagalski and Dubrovsky (1991) completed a regional assessment of non-point source pesticide residues in groundwater of the San Joaquin Valley. Compounds detected in groundwater included: atrazine, bromacil, 2,4-DP, diazinon, DBCP, prometon, prometryn, propazine, and simazine. Significant conclusions of this report are presented below.

- Pesticide leaching is dependent on application patterns, soil texture, total organic carbon in soil, pesticide half-life, and depth to groundwater.

- Leaching is enhanced by flood irrigation methods.
- Foliar applied pesticides, such as diazinon, are not mobilized by flood irrigation and are less likely to be detected in groundwater.
- Shallower occurring groundwater in the western San Joaquin Valley has fewer detected pesticides than groundwater in the eastern San Joaquin Valley. The finer-grained soils of the western San Joaquin Valley inhibit pesticide leaching due to either low vertical permeability or high surface area. Both properties enhance adsorption of pesticides in the soil.
- Soils in the eastern San Joaquin Valley are coarse-grained sediments derived from the Sierra Nevada Batholith. Unlike the fine textured soils of the western San Joaquin Valley, these soils are susceptible to pesticide leaching and groundwater, particularly in areas where the water table is less than 100 feet, are vulnerable to groundwater degradation.
- The area that appears to be most susceptible to leaching is in eastern Fresno and Tulare Counties.
- Tritium was detected in samples where pesticides were detected. Tritium indicates recharge with water of recent origin (post 1952) indicating the water recently interacted with soils. Tritium is a useful indicator of possible contamination of groundwater by pesticides.
- Nitrate concentrations were not significantly different in groundwater samples where atrazine was or was not detected. Nitrate is not a useful indicator of possible contamination of groundwater by pesticides.

General Management Practices

BMPs to protect groundwater apply a combination of practices that include soil and water conservation practices, integrated pest management (IPM) systems, efficient pesticide application techniques, and substitution of less toxic, less persistent, or less “leachable” pesticides (NCAES 1988). The water quality coalitions have been requested to submit BMPs being utilized by coalition members; however, to date that information is not available. Specific pesticide application BMPs that can be employed to reduce the threat to groundwater have been presented by various authors (Waskom 1995; Wright et al. 1993). Many of these BMPs are also applicable to fertilizer and nutrient applications. Potential BMPs are listed below.

- Maintain application equipment in good working condition and calibrate frequently to ensure recommended rates are applied.
- Employ application techniques that increase efficiency and allow the lowest effective labeled application rate.
- Avoid unnecessary and poorly timed application of pesticides. Optimize rate, timing, and placement to obtain pest control without the need for retreatment.

- Time pesticide application in relation to soil moisture, anticipated weather conditions, and irrigation schedule to achieve the greatest efficiency and minimize leaching.
- Establish buffer zones where pesticide is not applied a safe distance from wells and surface water.
- Ensure that backflow prevention devices are installed and operating properly on irrigation systems used for applying pesticides.
- Consider application site characteristics (soil texture, slope, organic matter).
- Store pesticides in a locked weather tight enclosure for minimum amounts of time and a safe distance from any wells or surface water.
- Use good housekeeping practices to minimize spills and tank mixing should be done in the field with a portable tank and not near wells or surface water.
- Properly dispose of all wastes.

Additional BMPs for nutrient application have been identified (EPA 2001) and are summarized below.

- Annual collection and analysis of soil samples to determine application rates based on crop nutritional needs.
- Consider other sources of nutrients (such as irrigation water) in determining application rates.
- Applications should coincide with times of maximum crop uptake.
- Nutrients should be placed where accessible to the crop at the time of application.
- Nutrient application should be limited on slopes or areas with high runoff or overland flow.

Assessment of Data Adequacy

Significant amounts of data are available from the USGS, DPR, DWR, and other organizations for groundwater quality in the San Joaquin Valley. These data do not appear to have been compiled making assessment of the information time consuming and expensive. Compilation of the data was beyond the available time or budget to complete this summary. However, data reviewed indicates there are significant issues related to the impact of agricultural chemicals to groundwater quality in the San Joaquin Valley Groundwater Basin.

Published reports present numerous BMPs that can be implemented to minimize impacts to groundwater quality. However, additional information is needed regarding implementation of BMPs within the San Joaquin Valley so the effectiveness of these activities can be assessed.

San Joaquin Valley Groundwater Basin—San Joaquin River Hydrologic Region Subbasins

Cosumnes Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Cosumnes Subbasin is within the San Joaquin River HR and comprises an area of approximately 281,000 acres (439 mi^2), primarily in Sacramento and San Joaquin counties with a small portion of the subbasin in western Amador County (Figure 4-3). The subbasin is bounded on the south and southwest by the Eastern San Joaquin Subbasin and on the north by the South American Subbasin of the Sacramento Valley Groundwater Basin. Exposed bedrock of the Sierra Nevada Mountains comprises the eastern boundary of the subbasin.

Water-bearing units in the subbasin consist of continental deposits of the Miocene to Pliocene Mehrten Formation, older alluvium of Pliocene to Pleistocene age, and younger alluvium of Quaternary age. The cumulative thickness of these deposits ranges from a few hundred feet on the east near the Sierra Nevada foothills to over 2,500 feet along the western margin of the subbasin.

The Mehrten Formation crops out in a discontinuous band along the eastern margin of the subbasin and consists of gravels, sands, silt, and clay with interbedded tuff breccias. The sands and gravels are highly permeable with wells completed in these zones having high yields. The tuff breccias act as confining layers. Unit thickness ranges from 200 to 1,200 feet.

The older alluvium consists of loose to moderately compacted sand, silt, and gravel deposited in alluvial fans. Formation names assigned to these deposits include: Modesto Formation, Riverbank Formation, Victor Formation, Laguna Formation, Arroyo Seco Gravels, South Fork Gravels, and Fair Oaks Formation. These deposits crop out between the Sierra Nevada foothills and younger alluvium near the axis of the Valley. Unit thickness ranges from about 100 to 650 feet.

The younger alluvium consists of recent stream channel deposits and dredge tailings. The stream channel deposits include sediments laid down by active steams, terrace deposits, and overbank deposits. These deposits consist of silt, fine- to medium-grained sand, and gravels and occur primarily along the Sacramento, Cosumnes, and Mokelumne rivers.

Major Sources of Recharge

The primary source of recharge to the area is seepage from streams flowing from the Sierra Nevada Mountains and percolation of applied irrigation water. The estimated total annual natural and applied water recharge is approximately 270,000 acre-feet. Estimated groundwater extraction includes approximately 35,000 acre-feet annually for urban use and 94,000 acre-feet annually for agricultural use (DWR 2003).

Land Use

Land use within the approximately 281,000-acre subbasin is shown on Figure 4-5. Primary agricultural crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-103.

Table 4-103. Land Use in the Cossumnes Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	3,500
Field Crops	15,000
Grain and Hay	4,000
Pasture	23,000
Truck, Nursery, and Berry Crops	2,000
Vineyards	33,500
Total	**81,000**

Coalitions, Water Districts, Major Urban Areas

Identified water quality coalitions in the Cosumnes Groundwater Subbasin are the Sacramento Valley Water Quality Coalition in the Sacramento County portion of the subbasin and the San Joaquin County and Delta Coalition in the San Joaquin County portion of the subbasin.

Public entities within the Cosumnes Groundwater Subbasin are: Galt ID, Jackson Valley ID, North Delta WA, North San Joaquin WCD, Omochumne-Hartnell WD, Clay WD, Amador WA, Calaveras County WD, City of Galt Service Area, Rancho Murieta CSD, Sacramento County WD, Sacramento County MUD, and North San Joaquin WCD.

There are no major urban areas in the Cosumnes Subbasin.

Pertinent Ordinances or Regulations

San Joaquin County adopted a groundwater management ordinance in 1996 and an amendment in 2000 regarding extracting and exporting of groundwater from San Joaquin County. The ordinance requires that a permit be obtained for use of extracted groundwater outside the County boundaries.

Sacramento Metropolitan Water Authority adopted an AB3030 groundwater management plan in 1994. Agencies within the subbasin that are part of the authority include Galt ID, Hartnell WD, Clay WD, City of Galt Service Area, and Rancho Murieta CSD.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 900 wells in San Joaquin County and 566 wells in Sacramento County for analysis of pesticides. Verified detections of pesticides were reported in 45 wells in San Joaquin County and 3 wells in Sacramento County. Unverified detections of pesticides were reported in 84 wells in San Joaquin County and 31 wells in Sacramento County. Detected pesticides include atrazine and bentazon in Sacramento County with ACET, atrazine, bromacil, DACT, DEA, diuron, norflurazon, and simazine detected in San Joaquin County (Schuette et al. 2003). Groundwater samples collected from 1994 to 2000, from 22 public water supply wells to meet the requirements of Title 22 of the California Code of Regulations (Title 22) within the Cosumnes Subbasin were analyzed for pesticides. Pesticides were detected pesticides in groundwater from one well at a concentration that exceeded an applicable MCL (DWR 2003).

Inorganic Constituents

The overall quality of the groundwater for municipal and irrigation usage is considered to be good. Groundwater within the subbasin is typically a calcium-magnesium and calcium-sodium bicarbonate type water. Detected TDS concentrations range from 140 to 438 mg/L and average approximately 218 mg/L. Analysis of groundwater samples collected from 1994 to 2000, from 30 public water supply wells to meet the requirements of Title 22 within the

Cosumnes Subbasin did not detect nitrates at a concentration that exceeded the MCL (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

DWR (2003) reports that a groundwater model for the subbasin estimated that subsurface outflow from the basin is approximately 145,000 acre-feet annually.

Eastern San Joaquin Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Eastern San Joaquin Subbasin is within the San Joaquin River HR and comprises an area of approximately 707,000 acres (1,110 mi^2) in San Joaquin, Stanislaus, and Calaveras counties (Figure 4-3). The subbasin is bounded by the Modesto Subbasin on the south, Delta-Mendota Subbasin on the southwest, Tracy Subbasin on the west, and on the north and northwest by the Cosumnes, South Sacramento, and Solano subbasins. The Solano and South American Subbasins are part of the Sacramento Valley Groundwater Basin.

Water-bearing units of the subbasin include undifferentiated deposits of alluvium and Modesto/Riverbank Formations, flood basin deposits, Laguna Formation, and Mehrten Formation.

The undifferentiated deposits of alluvium and the Modesto/Riverbank Formations are of Recent to Late Pleistocene in age and consist of sand and gravels deposited in alluvial fans and clay, silt, and sand deposited in interfan areas. These units range in thickness from a thin veneer along the eastern margin of the subbasin to 150 feet near the center of the valley.

The flood-basin deposits consist of Recent to Pliocene age sediments exposed in the delta area of the San Joaquin Valley. These sediments represent a finer-grained equivalent (more distal facies) of the alluvium and Modesto/Riverbank Formations as described above. These deposits consist primarily of fine-grained sand, silt, and clay with occasional gravel beds. Unit thickness ranges from 0 to 1,400 feet. This unit creates semi-confined to confined conditions when interfingered with coarser-grained deposits. This unit typically has low permeability and contains poor quality groundwater.

The Plio-Pleistocene Laguna Formation consists of discontinuous lenses of fluvial sand and silt with lesser amounts of clay and gravel. The unit thickens from approximately 400 feet near the Mokelumne River to 1,000 feet in the Stockton area.

The Miocene to Pliocene Mehrten Formation consists of moderately to well indurated andesitic sand interbedded with conglomerate, tuffaceous siltstone, and claystone. The unit is exposed along the eastern margin of the subbasin where it is approximately 400 feet thick. The unit appears to thicken westward in the subsurface with reported thicknesses of 600 feet near Stockton and 1,300 feet near McDonald Island.

Major Sources of Recharge

The primary source of recharge to the area is seepage from streams flowing from the Sierra Nevada Mountains and percolation of applied irrigation water. The estimated total annual recharge from precipitation and applied water is approximately 593,000 acre-feet, 141,000 acre-feet from infiltration of surface water, and 3,500 acre-feet of net subsurface inflow. Estimated groundwater extraction includes approximately 47,000 acre-feet annually for municipal and industrial use and 762,000 acre-feet annually for agricultural use (DWR 2003).

Land Use

Land use within the approximately 707,000-acre subbasin is shown on Figure 4-5. Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-104.

Table 4-104. Land Use in the Eastern San Joaquin Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	102,500
Field Crops	70,500
Grain and Hay	55,000
Pasture	65,500
Truck, Nursery, and Berry Crops	44,000
Vineyards	59,000
Total	**396,500**

Coalitions, Water Districts, Major Urban Areas

Coalitions in the subbasin include the San Joaquin County & Delta Coalition in the San Joaquin County portion of the subbasin and the East San Joaquin River Water Quality Coalition in the Stanislaus County portion of the subbasin.

Public water entities within the Eastern San Joaquin Groundwater Subbasin include: Lockeford CSD, North Delta WA, North San Joaquin WCD, Oakdale ID, City of Lathrop WD, City of Lodi Service Area, City of Manteca WSA, Calaveras County WD, California Water Service Company, Central Delta WA, Central San Joaquin WCD, City of Escalon WSA, RD 828, River Junction RD 2064, Rock Creek WD, South Delta WA, South San Joaquin ID, Stockton East WD, Valley Springs PUD, Woodbridge ID, Woodbridge WUCD, San Joaquin County FC&WCD, and City of Stockton MUD.

Major urban areas in the subbasin include the Cities of Stockton and Lodi.

Pertinent Ordinances or Regulations

San Joaquin County adopted a groundwater management ordinance in 1996 and an amendment in 2000, regarding extracting and exporting of groundwater from San Joaquin County. The ordinance requires that a permit be obtained for use of extracted groundwater outside the County boundaries.

Calaveras County adopted a groundwater management ordinance in 2002, requiring that a County permit be obtained for extracting groundwater for use outside the County.

AB3030 groundwater management plans have been adopted by Stanislaus County, Oakdale ID, San Joaquin County FC&WCD, South San Joaquin ID, Stockton East WD, and Woodbridge WD.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 900 wells in San Joaquin County and 900 wells in Stanislaus County for analysis of pesticides. Groundwater samples from 45 wells in San Joaquin County and 45 wells in Stanislaus County had verified detections of pesticides. San Joaquin County had 84 unverified detections while Stanislaus had 171 unverified detections. Pesticides detected in both counties include: ACET, atrazine, bromacil, DACT, DEA, diuron and simazine. In addition, the pesticides bentazon and prometon were detected in Stanislaus County and norflurazon was detected in San Joaquin County (Schuette et al. 2003).

Inorganic Constituents

Most groundwater within the subbasin is a calcium-magnesium bicarbonate or calcium-sodium bicarbonate type water. Along the western margin of the subbasin near the San Joaquin River, chloride becomes the dominant anion. Analysis of groundwater samples from 174 water supply wells in the subbasin detected TDS concentrations from 30 to 1,632 mg/L with an average of 310 mg/L. Other studies have reported TDS concentrations of groundwater ranging from 463 mg/L to 3,520 mg/L with an average of 463 mg/L (DWR 2003).

Large areas of the subbasin southeast of Lodi and south of Stockton and east of Manteca (extending toward the Stanislaus-San Joaquin County line have elevated concentrations of nitrates (DWR 2003).

Intrusion of saline water has been occurring along a 16-mile front on the east side of the Delta. The front moved approximately 1 mile east from 1963 to 1996. It is believed that declining groundwater levels have allowed the intrusion of saline water (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

The primary discharge pathway for groundwater from the subbasin is by the estimated 70,000 acre-feet per year overdraft (DWR 2003).

Tracy Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Tracy Subbasin is within the San Joaquin River HR and comprises an area of approximately 345,000 acres (539 mi^2) in San Joaquin, Contra Costa, and Alameda counties (Figure 4-3). The subbasin is bounded by the Solano subbasin of the Sacramento Groundwater Basin to the north, the Eastern San Joaquin Subbasin to the east, and the Delta-Mendota Subbasin to the south.

Water-bearing units of the Tracy Subbasin consist of Late Tertiary to Quaternary continental deposits of the Tulare Formation, older alluvium, flood basin deposits, and younger alluvium. The cumulative thickness of these deposits ranges from a few hundred feet along the edge of the Coast Ranges to about 3,000 feet along the eastern margin of the subbasin.

The Tulare Formation is exposed in the Coast Ranges west of the subbasin and dips eastward towards the axis of the valley. This unit consists of discontinuous deposits of clay, silt, and gravel that are poorly sorted and semiconsolidated. The Corcoran clay (also referred to as the e-clay) occurs near the top of the formation and confines groundwater beneath. The eastern limit of the Corcoran clay is near the eastern subbasin boundary. Groundwater is produced both from the unconfined aquifer above the Corcoran clay and the confined aquifer below. However, poor quality water is often encountered above the Corcoran clay. Maximum thickness of the Tulare Formation is about 1,400 feet.

The older alluvium is commonly exposed between the Coast Ranges and the Delta. This unit consists of loosely to moderately compacted sand, silt, and gravel deposited in alluvial fans during the Plio-Pleistocene. The older alluvium is about 150 feet thick.

The younger alluvium includes channel and overbank deposits of active streams and terrace deposits of those streams. These deposits are present primarily along Corral Hollow Creek and consist of unconsolidated silt, fine- to medium-grained sand, and gravel. This unit is less than 100 feet thick in the subbasin.

Flood basin deposits occur in the Delta portion of the subbasin. This unit consists primarily of silt and clay with occasional gravel interbeds and is the distal equivalent of the older and younger alluvium and the Tulare Formation. Groundwater found within this unit, it is generally of poor quality. The maximum thickness of the flood basin deposits is about 1,400 feet.

Major Sources of Recharge

The primary source of recharge to the area is seepage from streams and percolation of applied irrigation water.

Land Use

Land use within the approximately 345,000-acre subbasin is shown on Figure 4-4. Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-105.

Table 4-105. Land Use in the Tracy Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	17,000
Field Crops	63,500
Grain and Hay	28,500
Pasture	47,500
Truck, Nursery, and Berry Crops	45,000
Vineyards	2,500
Total	**204,000**

Coalitions, Water Districts, Major Urban Areas

The San Joaquin County and Delta Coalition is the only identified water quality coalition in the subbasin.

Identified public agencies within the Tracy Groundwater Subbasin are: Naglee Burk ID, North Delta WA, Contra Costa WD, Diablo WD, East Contra Costa WD, Alameda CFC&WCD, Banta-Carbona WD, Byron Bethany ID, Central Delta WA, City of Antioch WSA, City of Brentwood WSA, Pescadero RD 2058, Plain View WD, RD 2039, South Delta WA, Stockton-East WD, The West Side ID, and West Stanislaus ID.

The only identified major urban area is the City of Tracy.

Pertinent Ordinances or Regulations

San Joaquin County adopted a groundwater management ordinance in 1996 and an amendment in 2000, regarding extraction and exportation of groundwater from San Joaquin County. The ordinance requires that a permit be obtained for use of extracted groundwater outside the County boundaries.

The San Luis and Delta-Mendota Water Authority adopted an AB3030 groundwater management plan. The water authority is composed of the Banta-Carbona ID, City of Tracy, Del Puerto WD, Patterson WD, Plain View WD, San Joaquin County FC&WCD, West Side ID, and West Stanislaus ID.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 900 wells in San Joaquin County for analysis of pesticides. Groundwater samples from 45 of the wells had verified detections of pesticides and 84 of the wells had unverified detections. Pesticides detected included: ACET, atrazine, bromacil, DACT, DEA, diuron, norflurazon, and simazine (Schuette et al. 2003). DPR also reported data for Alameda and Contra Costa Counties; however, it is not summarized here because only a minor portion of each county is within the Tracy Subbasin.

Inorganic Constituents

Groundwater beneath the northern part of the subbasin is a sodium bicarbonate, chloride, and mixed bicarbonate-chloride type water. The dominant cations in groundwater beneath the southern part of the subbasin are calcium and sodium while the anionic water type is sulfate to chloride and bicarbonate to chloride. TDS concentrations in San Joaquin and Contra Costa counties range from 50 to 3,520 mg/L with a mean of 463 mg/L. The highest TDS concentrations are found in the western and central parts of the subbasin. Analysis of groundwater samples from 36 water supply wells within the subbasin had TDS concentrations from 210 to 7,800 mg/L with an average of 1,190 mg/L (DWR 2003).

The northwestern part of the subbasin and around the city of Tracy has high nitrate levels. Boron is also elevated from the northwest side of the subbasin to just south of Tracy. Elevated chloride concentrations exist in several areas of the subbasin including: along the San Joaquin River, the northwestern part of the subbasin, and in the vicinity of the City of Tracy (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Modesto Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Modesto Subbasin is within the San Joaquin River HR and comprises an area of approximately 247,000 acres (385 mi^2) in Stanislaus County (Figure 4-3). The subbasin is bounded by the Stanislaus River to the north, San Joaquin River to the west, and Tuolumne River to the south. The Eastern San Joaquin Subbasin is to the north, Delta-Mendota Subbasin is to the west, Turlock Subbasin is to the south and bedrock of the Sierra Nevada is to the east.

Water-bearing units of the subbasin include consolidated and unconsolidated sedimentary deposits. The consolidated deposits include the Tertiary age Ione, Valley Springs, and Mehrten Formations. Unconsolidated deposits include Pliocene and younger deposits that from oldest to youngest have been identified as continental deposits, lacustrine and marsh deposits, older alluvium, younger alluvium, and flood basin deposits (DWR 2003).

The consolidated deposits are exposed along the eastern edge of the subbasin and only the Mehrten is considered an important aquifer. The Ione and Valley Springs yield only limited quantities of water to wells. The Mehrten is composed of up to 300 feet sandstone, breccia, conglomerate, tuff siltstone, and claystone.

The continental deposits and the older alluvium are the primary water-bearing units of the unconsolidated deposits. The continental deposits consist primarily of poorly sorted gravel, sand, silt, and clay with a maximum thickness of about 450 feet.

The older alluvium consists of interstratified beds of gravel, sand, silt, and clay. This unit is up to 400 feet thick and is typically at or near the surface of the western half of the subbasin. This unit is equivalent of the Modesto and Riverbank Formations.

The Corcoran clay occurs within the lacustrine and marsh deposits. The Corcoran clay is the confining layer that separates the overlying unconfined aquifer from the underlying confined aquifer. The Corcoran clay underlies the southwestern portion of the subbasin at depths of 150 to 250 feet (DWR 2003).

Major Sources of Recharge

The primary sources of groundwater recharge in the subbasin are from deep percolation of applied irrigation water and from canals and water storage facilities. Lesser groundwater recharge occurs from percolation from small streams, direct percolation of precipitation, and underflow down stream channels from the east. The lower to middle stretches of the Stanislaus and Tuolumne rivers are gaining streams with groundwater discharge supporting flow. Natural recharge to the subbasin is estimated at 86,000 acre-feet annually with an additional 92,000 acre-feet of recharge from applied water annually. Estimated annual extractions include 81,000 acre-feet for urban use and 145,000 acre-feet for agricultural use (DWR 2003).

Land Use

Land use within the approximately 247,000-acre subbasin is shown on Figure 4-5. Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-106.

Table 4-106. Land Use in the Modesto Subbasin

Land Use	Approximate Acreage
Agriculture	
Rice	2,000
Deciduous Fruits and Nuts	44,000
Field Crops	20,000
Grain and Hay	3,500
Pasture	37,000
Truck, Nursery, and Berry Crops	1,500
Vineyards	5,500
Total	**113,500**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition in the subbasin is the East San Joaquin River Water Quality Coalition. Public water agencies within the Modesto

Groundwater Subbasin are: Modesto ID, Oakdale ID, Stanislaus and Tuolumne Rivers Groundwater Subbasin Association, City of Modesto, City of Oakdale, and City of Riverbank.

The only major urban area in the subbasin is the City of Modesto.

Pertinent Ordinances or Regulations

There are no pertinent groundwater ordinances or regulations in Stanislaus County.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 900 wells in Stanislaus County for analysis of pesticides. Groundwater samples from 45 of the wells had verified detections of pesticides and 171 of the wells had unverified detections. Detected pesticides included ACET, atrazine, bentazon, diuron, bromacil, DACT, DEA, prometon, and simazine (Schuette et al. 2003). Groundwater samples collected from 117 water supply wells regulated by the DHS within the subbasin from 1994 through 2000 were analyzed for pesticides. Pesticides were detected in groundwater from 14 wells at concentrations greater than an applicable MCL (DWR 2003).

Inorganic Constituents

Groundwater beneath the eastern part of the subbasin is typically a calcium bicarbonate type water while groundwater beneath the western portion of the subbasin is typically a calcium-magnesium bicarbonate or calcium-sodium bicarbonate type water. TDS concentrations range from 60 to 8,300 mg/L and typically fall between 200 and 500 mg/L. Analysis of 88 groundwater samples from wells regulated by DHS had TDS concentrations ranging from 60 mg/L to 860 mg/L with an average concentration of 295 mg/L (DWR 2003).

There are localized areas of high chloride, boron, DBCP, nitrate, iron, and manganese. The eastern side of the subbasin has some areas with elevated sodium chloride and high TDS. 114 groundwater samples for analysis of nitrate were collected from water supply wells regulated by DHS from 1994 through 2000. Three of these wells contained groundwater with nitrate concentrations greater than the MCL (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal. Groundwater discharges for the subbasin are not known.

Turlock Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Turlock Subbasin is within the San Joaquin River HR and covers approximately 347,000 acres (542 mi^2) in Stanislaus and Merced Counties (Figure 4-3). The subbasin is bounded to the north by the Tuolumne River, to the south by the Merced River, and to the west by the San Joaquin River. The Modesto subbasin lies to the north, Delta-Mendota subbasin to the west, and Merced Subbasins to the south with bedrock of the Sierra Nevada to the east.

Water-bearing units of the subbasin include consolidated and unconsolidated sedimentary deposits. The consolidated deposits include the Tertiary age Ione, Valley Springs, and Mehrten Formations. Unconsolidated deposits include Pliocene and younger deposits that from oldest to youngest have been identified as continental deposits, older alluvium, younger alluvium, and flood basin deposits.

The consolidated units include the Ione, Valley Springs, and Mehrten Formations. Most of the consolidated material lies in the eastern portion of the subbasin and yield little water with the exception of the Mehrten Formation. The Mehrten Formation is composed of up to 800 feet of sandstone, breccia, conglomerate, tuff siltstone, and claystone.

Unconsolidated materials include continental, older and younger alluvium, and flood basin deposits. In the western half of the subbasin the Corcoran or E-clay aquitard is composed of lacustrine and marsh deposits ranges at depths between about 50 and 200 feet. The lacustrine, flood-subbasin deposits and marsh deposits yield very little water. The younger alluvium yields only moderate quantities of water.

Given the stratigraphy of the Turlock Subbasin, there are three groundwater bodies: unconfined, semiconfined and confined in the consolidated material, and the confined water beneath the E-clay in the western portion of the subbasin.

Major Sources of Recharge

The primary sources of groundwater recharge in the subbasin are from deep percolation of applied irrigation water and from canals and water storage facilities. Lesser groundwater recharge occurs from percolation from small streams, direct percolation of precipitation, and underflow down stream channels from the east. Natural recharge is estimated at 33,000 acre-feet annually while recharge of applied water is estimated at 313,000 acre-feet annually. Annual groundwater extraction is estimated at 65,000 acre-feet for urban use and 387,000 acre-feet for agricultural use (DWR 2003).

Land Use

Land use within the approximate 347,000-acre subbasin is shown on Figure 4-5. Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-107.

Table 4-107. Land Use in the Turlock Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	105,500
Field Crops	60,000
Grain and Hay	6,000
Pasture	42,500
Truck, Nursery, and Berry Crops	5,000
Vineyards	15,500
Total	**234,500**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition in the subbasin is the East San Joaquin River Water Quality Coalition.

Public water agencies within the Turlock Groundwater Subbasin include: Eastside WD, Turlock ID, Ballico-Cortez WD (inactive), and Merced ID.

The only identified major urban area in the subbasin is the City of Turlock.

Pertinent Ordinances or Regulations

There are no known pertinent groundwater ordinances or regulations in Merced or Stanislaus County.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 900 wells in Stanislaus County and 1,230 in Merced County for analysis of pesticides. In Stanislaus County, groundwater samples from 45 of the wells had verified detections and 171 of the wells had unverified detections of pesticides. In Merced County, groundwater samples from 25 of the wells had verified detections and 72 of the wells had unverified detection of pesticides. Detected pesticides included ACET, atrazine, bentazon, diuron, bromacil, DACT, DEA, prometon, and simazine (Schuette et al. 2003). Groundwater samples collected from 117 water supply wells regulated by DHS within the subbasin from 1994 through 2000 were analyzed for pesticides. Pesticides were detected in groundwater from 14 wells at concentrations greater than an applicable MCL (DWR 2003).

Inorganic Constituents

Groundwater in the subbasin is typically a sodium-calcium bicarbonate type water with sodium bicarbonate and sodium chloride type waters at the western margin and in a small area of the north-central part of the subbasin. TDS ranges from 100 to 8,300 mg/L, but usually range from 200 to 500 mg/L. Analysis of groundwater samples collected from 71 wells regulated by DHS had TDS concentrations from 100 to 930 mg/L, with an average of 335 mg/L (DWR 2003).

Localized areas of the subbasin have groundwater with concentrations of nitrates, chlorides, boron, and DBCP that impair the beneficial uses. Analysis of groundwater samples collected from 90 wells regulated by DHS between 1994 and 2000, detected nitrate in groundwater from eight of the wells at concentrations exceeding the MCL. A City of Turlock well was closed because of nitrate concentrations (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Merced Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Merced Subbasin is within the San Joaquin River HR and covers approximately 491,000 acres (767 mi^2) in Merced County (Figure 4-3). Surrounding subbasins include: the Chowchilla Subbasin to the south, Turlock Subbasin to the north, and Delta-Mendota Subbasin to the west. Crystalline bedrock of the Sierra Nevada lies to the east.

Water-bearing units within the subbasin consist of consolidated rock and unconsolidated deposits. The consolidated units include the Tertiary-age Ione, Valley Springs, and Mehrten Formations. Most of the consolidated material lies in the eastern portion of the subbasin and yield little water with the exception of the Mehrten Formation. The Mehrten Formation is composed of sandstone, breccia, conglomerate, tuff siltstone, and claystone.

The unconsolidated deposits are Pliocene and younger in age and from oldest to youngest include: continental deposits, lacustrine and marsh deposits, older alluvium, younger alluvium, and flood basin deposits. Among the unconsolidated units, the main water yielding units are the continental and older alluvium deposits. The lacustrine and marsh deposits, including the Corcoran Clay and the flood basin deposits yield little water while the younger alluvium generally yields moderate quantities of water.

An unconfined aquifer occurs in the unconsolidated materials above and to the east of the Corcoran Clay. The Corcoran Clay occurs in the western half of the subbasin at depths ranging from 50 to 200 feet with the exception of the western and southern areas where clay lenses occur producing semiconfined conditions.

Major Sources of Recharge

The primary sources of groundwater recharge in the subbasin are from deep percolation of applied irrigation water and from canals and water storage facilities. Lesser groundwater recharge occurs from percolation from small streams, direct percolation of precipitation, and underflow down stream channels from the east. Natural recharge is estimated at 47,000 acre-feet annually while recharge of applied water is estimated at 243,000 acre-feet annually. Annual groundwater extraction is estimated at 54,000 acre-feet for urban use and 492,000 acre-feet for agricultural use (DWR 2003).

Land Use

Land use within the approximate 491,000-acre subbasin is shown on Figure 4-5. Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-108.

Table 4-108. Land Use in the Merced Subbasin

Land Use	Approximate Acreage
Agriculture	
Rice	3,500
Deciduous Fruits and Nuts	67,500
Field Crops	66,000
Grain and Hay	17,000
Pasture	61,500
Truck, Nursery, and Berry Crops	28,000
Vineyards	7,500
Total	**251,000**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition in the subbasin is the East San Joaquin River Water Quality Coalition.

Public water agencies within the Merced Subbasin include: Merced ID, Merquin County WD, Turner Island WD, Le Grand-Athlone WD, Plainsburg ID, and Stevinson WD.

The only identified major urban area in the subbasin is the City of Merced.

Pertinent Ordinances or Regulations

There are no known pertinent groundwater ordinances or regulations in Merced County.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 1,230 wells in Merced County for analysis of pesticides. Groundwater samples from 25 of the wells had verified detections and 72 of the wells had unverified detection of pesticides. Detected pesticides included ACET, atrazine, bentazon, diuron, bromacil, DACT, DEA, norflurazon, prometon, and simazine (Schuette et al. 2003). Groundwater samples collected from 62 water supply wells regulated by DHS within the subbasin from 1994 through 2000 were analyzed for pesticides. Pesticides were detected in groundwater from eight wells at concentrations greater than an applicable MCL (DWR 2003).

Inorganic Constituents

Groundwater is typically a sodium bicarbonate type water in western areas of the subbasin, calcium-magnesium bicarbonate type water in interior areas of the subbasin, and calcium-sodium bicarbonate type water in southern areas of the subbasin. Small areas of chloride type waters occur in the southwestern corner of the subbasin. TDS ranges from 100 to 3,600 mg/L, but usually range from 200 to 400 mg/L. Analysis of groundwater samples collected from 46 wells regulated by DHS had TDS concentrations from 150 to 424 mg/L, with an average of 231 mg/L (DWR 2003).

Localized areas of the subbasin have groundwater with concentrations of iron, nitrates, and chlorides that impair the beneficial uses. Analysis of groundwater samples collected from 64 wells regulated by DHS between 1994 and 2000, detected nitrate in groundwater from two of the wells at concentrations exceeding the MCL (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Delta-Mendota Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage, physiography, and water-bearing units; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Delta-Mendota Subbasin is within the San Joaquin River HR and covers approximately 747,000 acres (1,170 mi^2) in Stanislaus, Merced, Madera, and Fresno counties (Figure 4-3). The Delta-Modesto Subbasin is bounded on the west by the Tertiary and older marine sediments of the Coast Ranges, on the north by the Tracy Subbasin, on the south by the Westside Subbasin, and on the east by the Modesto, Turlock, Merced, Chowchilla, Madera, and Kings subbasins.

The water-bearing units include: the Tulare Formation, terrace deposits, alluvium, and flood basin deposits. The Tulare Formation is comprised of interbedded tongues and lenses of clay, sand, and gravel that were deposited in alternating oxidizing and reducing environments. A member of the Tulare Formation, the Corcoran Clay, is an aquitard that occurs at a depth ranging from 100 to 500 feet and acts as the confining layer that separates the underlying confined from the overlying unconfined aquifers.

Pleistocene terrace deposits of yellow, tan and light-to-dark brown silt, sand, and gravel lie are elevated above present day streambeds. These deposits typically occur above the water table, but their coarse grain size are potential recharge areas.

The alluvium consists of poorly to well-sorted clay, silt, sand, and gravel. Capping the other units of the subbasin are flood basin deposits, which are dark to light brown and gray clay, silt, sand, and organic materials.

The water-bearing zones of the Delta-Mendota Subbasin have lower, upper, and shallow zones. The lower zone is the lower section of the Tulare Formation. The upper zone is generally confined, semiconfined, and unconfined water in the upper section of the Tulare Formation and some younger deposits. The shallow zone is unconfined within 25 feet of the land surface.

Major Sources of Recharge

The primary sources of groundwater recharge in the subbasin are from deep percolation of applied irrigation water and from canals and water storage facilities. Lesser groundwater recharge occurs from percolation from small streams and direct percolation of precipitation. Natural recharge is estimated at 8,000 acre-feet annually while recharge of applied water is estimated at 74,000 acre-feet annually. Annual groundwater extraction is estimated at 17,000 acre-feet for urban use and 491,000 acre-feet for agricultural use (DWR 2003).

Land Use

Land use within the approximate 747,000-acre subbasin is shown on Figure 4-5. Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-109.

Table 4-109. Land Use in the Delta-Mendota Subbasin

Land Use	Approximate Acreage
Agriculture	
Rice	8,000
Deciduous Fruits and Nuts	52,500
Field Crops	207,500
Grain and Hay	18,500
Pasture	104,500
Truck, Nursery, and Berry Crops	81,500
Vineyards	2,500
Total	**475,000**

Coalitions, Water Districts, Major Urban Areas

Identified water quality coalitions within the subbasin are the Westside Water Quality Coalition and the San Luis WD Water Quality Coalition.

Public water agencies within the Delta-Mendota Groundwater Subbasin include: Merced County, Fresno County, Broadview WD, Centinella WD, Central California ID, Davis WD, Del Puerto WD, Eagle Field WD, El Solyo WD, Farmers WD, Firebaugh Canal WD, Foothill WD, Fresno Slough WD, Grasslands WD, Hospital WD, Kern Canon WD, Laguna WD, Mercy Springs WD, Mustang WD, Oak Flat WD, Orestimba WD, Oro Loma WD, Pacheco WD, Panoche WD, Patterson WD, Romero WD, Salado WD, San Luis Canal Company, San Luis WD, Santa Nella CWD, Sunflower WD, Tranquility ID, West Stanislaus ID, Widren WD, and Quinto WD.

There are no identified major urban areas within the subbasin.

Pertinent Ordinances or Regulations

Pertinent ordinances and regulations affecting groundwater in the subbasin are listed below.

- Fresno County has a Groundwater Management Ordinance restricting the extraction and transfer of groundwater outside of the County. The ordinance states:

  > The protection of the health, welfare, and safety of residents of the county, and the public benefit of the state, require that groundwater resources of Fresno County be protected from harm resulting from the extraction and transfer of groundwater for use on lands outside the county, and from harm resulting from the extraction of groundwater for use on lands within the county to substitute for the consequential transfer of surface water outside of the county, until such time as needed additional surface water supplies are obtained for use on lands of the county, or overdrafting is alleviated.

  A County-issued permit is required for groundwater transfer, directly or indirectly, outside of the County, unless the action is exempted or a permit first obtained.

- Madera County has a Groundwater Management Ordinance that regulates the importation of foreign water for the purpose of groundwater banking and exportation of groundwater outside Madera County.

No known groundwater ordinances have been adopted by Stanislaus or Merced Counties.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 900 wells in Stanislaus County, 1,230 wells in Merced County, 391 wells in Madera County, and 4,032 wells in Fresno County for analysis of pesticides. In Stanislaus County, groundwater samples from 45 of the wells had verified detections and 171 of the wells had unverified detections. In Merced County, groundwater samples from 25 of the wells had verified detections and 72 of the wells had unverified detections. In Madera County, groundwater samples from 11 of the wells had verified detections and 89 of the wells had unverified detections. In Fresno County, groundwater samples from 224 of the wells had verified detections and 369 of the wells had unverified detections. ACET, atrazine, bromacil, DACT, DEA, diuron, and simazine were detected in each of the counties. Norflurazon was detected in Fresno and Merced counties (Schuette et al. 2003). Groundwater samples collected from 47 water supply wells regulated by DHS within the subbasin from 1994 through 2000 were analyzed for pesticides. Pesticides were detected in groundwater from one well at concentrations greater than an applicable MCL (DWR 2003).

Inorganic Constituents

Groundwater in the subbasin is typically a mixed sulfate to bicarbonate type water. In the central and southern portions of the subbasin, areas of sodium chloride and sodium sulfate type groundwater exist. TDS concentrations range from 400 to 1,600 mg/L in the northern part of the subbasin and 730 to 6,000 mg/L in the southern part. Analysis of groundwater samples collected from 44 wells regulated by DHS had detected TDS concentrations from 210 to 1,750 mg/L, with an average of 770 mg/L (DWR 2003).

Localized areas of the subbasin have groundwater with concentrations of iron, fluoride, nitrate, and boron that impair the beneficial uses. Analysis of groundwater samples collected from 51 wells regulated by DHS between 1994 and 2000, detected nitrate in groundwater from 4 of the wells at concentrations exceeding the MCL (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Chowchilla Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage, physiography, and water-bearing units; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Chowchilla Subbasin is within the San Joaquin River HR and covers approximately 159,000 acres (248 mi^2) in Madera and Merced counties (Figure

4-3). The subbasin is bordered to the north by the Merced Subbasin, to the southeast by Madera Subbasin and to the west by Delta-Mendota Subbasin. Crystalline bedrock of the Sierra Nevada comprises the subbasin's eastern boundary.

The major water-bearing units within the Chowchilla Subbasin are unconsolidated continental deposits of Tertiary and Quaternary age. Quaternary age deposits include older alluvium, lacustrine and marsh deposits, and younger alluvium that crop out over most of the subbasin and yield 95% of the well water. The most important source of water is the older alluvium, which is characterized as being intercalated lenses of clay, silt, sand, and some gravel. The Corcoran Clay or E-Clay underlies most of the basin at depths between 50 and 250 feet and restricts the vertical movement of water.

Major Sources of Recharge

The primary source of groundwater recharge in the subbasin is from deep percolation of applied irrigation water. Lesser groundwater recharge occurs from percolation from streams and direct percolation of precipitation. Natural recharge is estimated at 87,000 acre-feet annually while recharge of applied water is estimated at 179,000 acre-feet annually. Annual groundwater extraction is estimated at 6,000 acre-feet for urban use and 249,000 acre-feet for agricultural use (DWR 2003).

Land Use

Land use within the approximate 159,000-acre subbasin is shown on Figure 4-5. Primary crops grown, and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-110.

Table 4-110. Land Use in the Chowchilla Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	29,000
Field Crops	40,500
Grain and Hay	8,000
Pasture	38,000
Truck, Nursery, and Berry Crops	1,000
Vineyards	12,500
Total	**129,000**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the subbasin is the East San Joaquin River Water Quality Coalition.

Public water agencies include: Chowchilla WD, Clayton WD, El Nido ID, New Stone WD, and Sierra WD (inactive). California Water Service Company is the only identified private water agency in the subbasin.

There are no identified urban areas containing 50,000 people within the subbasin.

Pertinent Ordinances or Regulations

Madera County has adopted an ordinance to provide regulatory control over the exporting groundwater, groundwater banking, and importing groundwater for the purpose of groundwater banking. There are no known pertinent groundwater regulations in Merced County.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 1,230 wells in Merced County and 391 wells in Madera County for analysis of pesticides. In Merced County, groundwater samples from 25 of the wells had verified detections and 72 of the wells had unverified detections. In Madera County, groundwater samples from 11 of the wells had verified detections and 89 of the wells had unverified detections. ACET, atrazine, bromacil, DACT, DEA, diuron, and simazine were detected in both counties. Norflurazon was detected in Merced County (Schuette et al. 2003). Groundwater samples collected from 12 water supply wells regulated by DHS within the subbasin from 1994 through 2000 were analyzed for pesticides. Pesticides were not detected in groundwater from any of these wells at a concentration greater than an applicable MCL (DWR 2003).

Inorganic Constituents

Groundwater in the subbasin is typically a calcium-sodium bicarbonate type water in the eastern part of the subbasin and grades to a calcium bicarbonate, sodium-calcium bicarbonate, and sodium chloride type waters towards the western portion of the subbasin. TDS concentrations range from 120 to 6,400 mg/L, but are typically in a range from 200 to 500 mg/L. Analysis of groundwater samples collected from 8 wells regulated by DHS had TDS concentrations from 120 to 390 mg/L, with an average TDS concentration of 228 mg/L (DWR 2003).

Localized areas of the subbasin have groundwater with concentrations of iron, nitrate, and chloride that impair beneficial use. Analysis of groundwater samples collected from 10 wells regulated by DHS between 1994 and 2000, did not detect nitrate in groundwater at a concentration exceeding the MCL from any of the wells (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Madera Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage, physiography, and water-bearing units; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Madera Subbasin is within the San Joaquin River HR and covers approximately 394,000 acres (614 mi^2) in Madera County (Figure 4-3). The Madera Subbasin is bounded to the east by crystalline bedrock of the Sierra Nevada, to the south by the Kings Subbasin, the Delta-Mendota Subbasin to the west, and the Chowchilla Subbasin to the north.

The water-bearing units in the Madera Subbasin consist of unconsolidated Pleistocene and Holocene age deposits. Quaternary continental deposits include older and younger alluvium, lacustrine, and marsh deposits that crop out over most of the Madera Subbasin and probably yield 95% of the well water. The most important part of the Quaternary deposits is the older alluvium. The older alluvium consists of intercalated lenses of clay, silt, sand, and some gravel. Within the older alluvium are lacustrine and marsh deposits that contain the E-Clay. The E-Clay does not crop out, but occurs at depths between 150 and 300 feet and restricts vertical movement of water.

Older Continental deposits of Tertiary and Quaternary, which include the Ione Formation, crop out along the subbasin's eastern margin and may yield small quantities of water.

Major Sources of Recharge

The primary source of groundwater recharge in the subbasin is from deep percolation of applied irrigation water. Lesser groundwater recharge occurs from percolation from streams and direct percolation of precipitation. Natural recharge is estimated at 21,000 acre-feet annually while recharge of applied water is estimated at 404,000 acre-feet annually. Annual groundwater extraction is estimated at 15,000 acre-feet for urban use and 551,000 acre-feet for agricultural use (DWR 2003).

Land Use

Land use within the approximate 394,000-acre subbasin is shown on Figure 4-5. Primary crops grown, and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-111.

Table 4-111. Land Use in the Madera Subbasin

Land Use	Approximate Acreage
Agriculture	
Citrus and Subtropical	7,000
Deciduous Fruits and Nuts	81,000
Field Crops	21,500
Grain and Hay	16,000
Pasture	16,500
Truck, Nursery, and Berry Crops	2,500
Vineyards	97,500
Total	**242,000**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the subbasin is the East San Joaquin River Water Quality Coalition.

Public water agencies within the Madera Groundwater Subbasin include: Gravelly Ford WD, Madera ID, and Root Creek WD. There are no known private water agencies within the subbasin.

The largest urban area within the subbasin is the City of Madera with a population of approximately 46,000 people.

Pertinent Ordinances or Regulations

Madera County has adopted an ordinance to provide regulatory control over exporting of groundwater, groundwater banking, and importing of groundwater for the purpose of groundwater banking.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

DPR reported that between 1983 and 2003, groundwater samples were collected from 391 wells in Madera County for analysis of pesticides. Groundwater samples from 11 of the wells had verified detections and 89 of the wells had unverified detections. Detected pesticides include: ACET, atrazine, bromacil, DACT, DEA, diuron, and simazine (Schuette et al. 2003). Groundwater samples collected from 46 water supply wells regulated by DHS within the subbasin from 1994 through 2000 were analyzed for pesticides. Pesticides were detected in groundwater samples from 3 of the wells at a concentration greater than an applicable MCL (DWR 2003).

Inorganic Constituents

Groundwater in the subbasin is typically a calcium-sodium bicarbonate type water with sodium bicarbonate and sodium chloride type waters along the western margin of the subbasin. TDS ranges from 100 to 6,400 mg/L, but are typically in a range from 200 to 400 mg/L. Analysis of groundwater samples collected from 40 wells regulated by DHS had TDS concentrations from 100 to 400 mg/L, with an average TDS concentration of 251 mg/L (DWR 2003).

Localized areas of the subbasin have groundwater with concentrations of iron, nitrate, and chloride that impair the beneficial uses. Analysis of groundwater samples collected from 43 wells regulated by DHS between 1994 and 2000, detected nitrate in groundwater at a concentration exceeding the MCL in one of the wells (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the deep percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

San Joaquin Valley Groundwater Basin—Tulare Lake Hydrologic Region Subbasins

Westside Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage, physiography, water-bearing units; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Westside Subbasin is within the Tulare Lake HR and comprises an area of approximately 640,000 acres (1,000 mi^2) located in the western portion of Fresno County and the northwestern portion of Kings County (Figure 4-4). The subbasin is bordered on the southwest by the Pleasant Valley Subbasin, the north, the northeast by the Delta-Mendota Subbasin, the east by the Kings Subbasin, the southeast by the Tulare Lake Subbasin, and on the west by Tertiary marine sediments of the Coast Ranges.

The water-bearing units comprising the Westside Subbasin consist of unconsolidated continental deposits of Tertiary and Quaternary age. These deposits form an unconfined to semiconfined upper aquifer and a confined lower aquifer. These aquifers are separated by the Corcoran Clay (E-Clay) member of the Tulare Formation (DWR 2003). The depth to the top of the Corcoran Clay varies from approximately 500 feet to 850 feet (DWR 1981).

The unconfined to semiconfined aquifer (upper zone) above the Corcoran Clay includes younger alluvium, older alluvium, and the upper part of the Tulare Formation. These deposits consist of lenticular, poorly sorted clay, silt, and sand intercalated with occasional beds of well-sorted fine to medium grained sand.

The confined aquifer (lower zone) consists of the lower part of the Tulare Formation and possibly the uppermost part of the San Joaquin Formation. This unit is composed of lenticular beds of silty clay, clay, silt, and sand interbedded with occasional strata of well-sorted sand. Brackish or saline water underlies the usable groundwater in the lower zone.

Fine-grained flood basin deposits along the east side of the subbasin restrict the downward movement of percolating water. In certain areas this causes percolation of applied water to buildup as shallow water (perched) in the near surface zone. This shallow groundwater is typically of poor quality and is not a significant source of produced groundwater.

The Corcoran Clay is a lacustrine diatomaceous clay unit that underlies much of the sub basin. Within the subbasin it varies in thickness from 20 to 120 feet. Prior to groundwater development, the Corcoran Clay effectively separated the upper and lower zones. Numerous wells penetrate the clay and have allowed partial interaction between the zones.

Major Sources of Recharge

The main source of recharge to the subbasin aquifer system is from the seepage of Coast Range streams along the west side of the subbasin and deep percolation of surface irrigation. Recharge to the lower aquifer occurs by subsurface flow from areas to the east and northeast.

Seepage from west side streams was estimated to amount to 30,000-40,000 acre-feet per year. For 1951, secondary recharge from the east into the upper aquifer was 20,000–30,000 acre-feet and was 150,000–200,000 acre-feet into the lower aquifer (DWR 2003).

Westlands WD (Westlands) estimated the average deep percolation between 1978 and 1996 was 244,000 acre-feet per year. Westlands also estimated the average applied groundwater between 1978 and 1997 was 193,000 acre-feet per year (DWR 2003).

Land Use

Land use within the approximate 744,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-112.

Table 4-112. Land Use in the Westside Subbasin

Land Use	Approximate Acreage
Agriculture	
Citrus and Subtropical	1,000
Deciduous Fruits and Nuts	56,500
Field Crops	321,000
Grain and Hay	46,000
Pasture	31,000
Truck, Nursery, and Berry Crops	174,000
Vineyards	12,500
Total	**642,000**

Coalitions, Water Districts, Major Urban Areas

The Westlands WD Water Coalition is the only identified water quality coalition within the subbasin.

Westlands WD is the only identified public water agency within the Westside Subbasin. There are no identified private water agencies within the subbasin.

There are no identified major urban areas in the subbasin.

Pertinent Ordinances or Regulations

Pertinent ordinances and regulations affecting the Westside Subbasin are as follows:

- AB3030, California Groundwater Management Plan, adopted in 1992.
- Fresno County has a Groundwater Management Ordinance restricting the extraction and transfer of groundwater outside of the County. The ordinance states:

  > The protection of the health, welfare, and safety of residents of the county, and the public benefit of the state, require that groundwater resources of Fresno County be protected from harm resulting from the extraction and transfer of groundwater for use on lands outside the county, and from harm resulting from the extraction of groundwater for use on lands within the county to substitute for the consequential transfer of surface water outside of the county, until such time as needed additional surface water supplies are obtained for use on lands of the county, or overdrafting is alleviated.

  A County-issued permit is required for groundwater transfer, directly or indirectly, outside of the County, unless the action is exempted or a permit first obtained.

No known pertinent groundwater ordinances have been adopted by Kings County.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR (Schuette et al. 2003) reports that between 1986 and 2003, 4,032 wells were sampled for pesticide residues in Fresno County and 229 wells were sampled in Kings County, both of which comprise portions of the Westside Subbasin. Fresno County had 224 wells with verified detections 369 wells with unverified detections while Kings reported 4 wells with verified detections and 6 wells with unverified detections. Fresno County detections included ACET, atrizine, bromacil, DACT, DEA, diuron, norflurazon, prometon, and simazine. Kings County had detections of atrizine, diuron, and prometon.

Various detections of selected compounds such as DBCP, xylenes, and ethyl dibromide were assumed to be the result of legal agricultural use prior to the Pesticide Contamination Prevention Act and therefore were not reviewed by the DPR.

Inorganic Constituents

Groundwater beneath the west side of the San Joaquin Valley is typically a sulfate or bicarbonate type water. Water quality of the upper aquifer is typically high in calcium and magnesium sulfate. Groundwater below 300 feet and above the Corcoran Clay shows a tendency of decreased dissolved solids with increased depth. Most of the groundwater in the lower aquifer is a sodium sulfate type water (DWR 2003).

Based on the analysis of groundwater samples collected from six wells regulated by DHS, the average TDS of the subbasin is 520 mg/L with a range from 220 mg/L to 1,300 mg/L. However, TDS concentrations in shallow groundwater can be greater than 10,000 mg/L at some locations in the lower fan areas of the subbasin with one sample having a TDS concentration of 35,000 mg/L. Groundwater in western Fresno County has an upper TDS concentration ranging from 2,000 to 3,000 mg/L (DWR 2003).

High TDS is an impairment of groundwater in the subbasin. Groundwater at certain locations also contains selenium and boron that may affect beneficial uses.

Bulletin 118 (DWR 2003) indicates that groundwater samples from 2 wells were analyzed for nitrates and detected concentrations were less than the MCL.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through improperly constructed water wells allowing migration of contaminant down the annular space.

There are no identified discharge pathways for groundwater to leave the subbasin. In areas of shallow or perched groundwater, groundwater can be discharged into nearby streams and/or canals.

Kings Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Kings Subbasin is within the Tulare Lake HR and comprises an area of approximately 976,000 acres (1,530 mi^2) primarily within Fresno County with the southern portion of the subbasin in Kings and Tulare Counties (Figure 4-4). The Kings Subbasin is bounded on the north by the Madera Subbasin, on the south by the Kaweah and Tulare Lake subbasins, and on the west by the Westside and Delta-Mendota Subbasins. Bedrock of the Sierra Nevada foothills bounds the subbasin on the east.

The water-bearing units of the Kings Subbasin consist of unconsolidated continental deposits. These deposits include an older series of Tertiary and Quaternary age sediments overlain by a younger series of Quaternary age sediments. The Quaternary age deposits are divided into older alluvium, lacustrine and marsh deposits, younger alluvium, and flood basin deposits.

The older alluvium consists of intercalated lenses of clay, silt, silty and sandy clay, clayey and silty sand, sand, gravel, cobbles, and boulders. It is, generally, fine grained near the trough of the valley. Lacustrine and marsh deposits are interbedded with the older alluvium in the western portion of the subbasin.

The younger alluvium consists of fluvial deposits of arkosic composition that overlie the older alluvium and are interbedded with the flood basin deposits. Its lithology is similar to the underlying older alluvium. Beneath river channels, the younger alluvium is highly permeable with lesser permeability beneath flood basin deposits. The flood basin deposits occur along the Fresno Slough and James Bypass. They consist of sand, silt, and clay.

The deposits of Quaternary age are exposed over most of the area and yield more than 90% of the water pumped from wells. The older continental deposits are exposed in the southeastern part of the subbasin and yield small amounts of water to wells.

Flood basin deposits provide minimal amounts of water to wells and typically restrict the flow of groundwater. The Corcoran Clay member of the Tulare

Formation is the most extensive of these deposits. The Corcoran Clay lies at a depth 250 to 550 feet in the western one quarter to one third of the subbasin.

Major Sources of Recharge

Groundwater recharge occurs from river and stream seepage, deep percolation of irrigation water, canal seepage, and intentional recharge. The Cities of Fresno and Clovis, Fresno ID, and Fresno Metropolitan Flood Control District have a cooperative effort to utilize individually owned facilities to recharge surplus surface water in the greater urban area. Fresno ID, Consolidated ID, and others have similar groundwater recharge efforts in the subbasin. The Fresno-Clovis metropolitan area uses a regional sewage treatment facility that percolates treated wastewater in ponds southwest of Fresno (DWR 2003). The percolation of treated wastewater has created a significant groundwater mound beneath the facility.

Groundwater flow is generally to the southwest. The potential exists for subsurface flows to the south and west. Depending upon local groundwater conditions in the Westside Subbasin, subsurface flows may occur in that direction. The potential exists for groundwater flow in either direction along the southern boundary of the subbasin. Groundwater depressions on either side of the subbasin boundary and groundwater mounding from recharge along the Kings River complicate flow patterns in the area (DWR 2003).

Land Use

Land use within the approximately 976,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-113.

Table 4-113. Land Use in the Kings Subbasin

Land Use	Approximate Acreage
Agriculture	
Citrus and Subtropical	52,500
Deciduous Fruits and Nuts	168,500
Field Crops	133,500
Grain and Hay	24,000
Pasture	78,000
Vineyards	263,000
Total	**719,500**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the Kings Subbasin is the South San Joaquin Valley Water Quality Coalition.

Public water agencies within the Kings Subbasin include: City of Fresno, City of Clovis, Alta ID, Consolidated ID, Fresno ID, Hills Valley ID, James ID, Kings River Conservation District (KRCD), Kings River WD, Laguna ID, Liberty WD, Mid-Valley WD, Orange Cove ID, Raisin City ID, Riverdale ID, and Tri-Valley ID. Identified private water agencies within the subbasin are California Water Service Company and Bakman Water Company.

Major urban areas include the Fresno-Clovis metropolitan area with a population in excess of 500,000.

Pertinent Ordinances or Regulations

Pertinent ordinances and regulations affecting the Kings Subbasin are as follows:

- Alta ID, Consolidated ID, County of Fresno, Fresno ID, James ID, KRCD, Kings River WD, Liberty Canal Company, Liberty WD, Liberty Mill Race Company, Mid Valley WD, Orange Cove ID, Raisin City WD, and Riverdale ID have adopted AB3030 Groundwater Management Plans.
- Fresno County has a Groundwater Management Ordinance restricting the extraction and transfer of groundwater outside of the County. The ordinance states:

  > The protection of the health, welfare, and safety of residents of the county, and the public benefit of the state, require that groundwater resources of Fresno County be protected from harm resulting from the extraction and transfer of groundwater for use on lands outside the county, and from harm resulting from the extraction of groundwater for use on lands within the county to substitute for the consequential transfer of surface water outside of the county, until such time as needed additional surface water supplies are obtained for use on lands of the county, or overdrafting is alleviated.

  A County-issued permit is required for groundwater transfer, directly or indirectly, outside of the County, unless the action is exempted or a permit first obtained.

No known pertinent groundwater ordinances have been adopted by Kings or Tulare Counties.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR (Schuette et al. 2003) reported that between 1986 and 2003, 4,032 wells were sampled for pesticide residues in Fresno County, 229 wells in Kings County, and 1,547 wells in Tulare County, all three of which comprise portions of the Kings subbasin. Fresno County had 224 wells with verified detections and 369 wells with unverified detections, Kings County reported 4 wells with verified detections and 6 wells with unverified detections, and Tulare County reported 365 wells with verified detections and 256 wells with unverified detections. Groundwater detections in Fresno and Tulare County included: ACET, atrizine, bromacil, DACT, DEA, diuron, norflurazon, prometon, and simazine. Groundwater detections in Kings County included: atrizine, diuron, and prometon.

Various detections of selected compounds such as DBCP, xylenes, and ethyl dibromide were assumed to be the result of legal agricultural use prior to the Pesticide Contamination Prevention Act and were not reviewed by DPR (Schuette et al. 2003). DBCP, a soil fumigant (nematicide), has been detected in groundwater along the eastern side of the subbasin (DWR 2003).

Inorganic Constituents

The groundwater in the Kings Subbasin is predominantly a bicarbonate type water. The major cations are calcium, magnesium, and sodium. Sodium appears higher in the western portion of the subbasin where some chloride waters are also found (DWR 2003).

The TDS of groundwater in the Fresno area seldom exceeds 600 mg/L although 2,000 mg/L groundwater has been encountered at greater depths. A typical range of TDS concentrations in groundwater in the subbasin is 200 to 700 mg/L. DHS data indicates an average TDS concentration of 240 mg/L in 414 samples collected from water supply wells subject to Title 22 regulations. The detected TDS concentrations of these samples ranged from 40 to 570 mg/L.

Analysis of groundwater samples collected from 463 wells detected nitrates at concentrations greater than the MCL in 23 of the wells.

Shallow brackish groundwater can be found in localized areas along the western portion of the subbasin. This shallow water contains elevated concentrations of fluoride, boron, and sodium (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through water wells with an inadequate surface seal.

Groundwater may flow to the west into the subbasin. Groundwater flow can be in or out of the subbasin along the northern and southern boundaries, depending on conditions (DWR 2003).

Tulare Lake Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Tulare Lake Subbasin is within the Tulare Lake HR and comprises an area of 524,000 acres (818 mi^2) primarily located in Kings County with a small portion along the eastern boundary of the subbasin within Tulare County (Figure 4-4). The Tulare Lake Subbasin is bordered on the north by the Kings Subbasin, on the northwest by the Westside Subbasin, to the east by the Kaweah and Tule Subbasins, and to the south by the Kern Subbasin. Tertiary marine sediments of the Kettleman Hills border the subbasin on the southwest.

Sediments comprising the Tulare Lake Subbasin include younger and older alluvium, flood basin deposits, lacustrine and marsh deposits, and continental deposits. Younger alluvium is a heterogeneous complex of interstratified discontinuous beds of unsorted to fairly well sorted clay, silt, sand, and gravel. This unit is very permeable but largely above the water table. Older alluvium consists of poorly sorted lenticular deposits of clay, silt, sand, and gravel, which may be loosely consolidated to cemented. Older alluvium is moderately to highly permeable and yields large quantities of water to wells. The unit is a major aquifer in the subbasin. Flood basin deposits are relatively impermeable silt and clay with some moderately to poorly permeable sand layers. This unit is not an important source of groundwater, but locally, may yield sufficient supplies for domestic and stock use. Lacustrine and marsh deposits are reduced deposits of silt, clay, and fine sand. In the subsurface, lacustrine clay interfingers with continental and alluvial deposits. The lacustrine and marsh deposits include the Corcoran Clay that underlies the sub basin at depths ranging between about 300 and 900 feet (DWR 1981). Continental deposits consist of poorly sorted lenticular deposits of clay, silt, sand, and gravel. These deposits are moderately to poorly permeable and yield low to large quantities of water to wells (DWR 2003).

Major Sources of Recharge

Groundwater recharge is primarily from percolation along stream channels and deep percolation of applied irrigation water. Natural recharge within the subbasin is estimated to be 89,200 acre-feet per year with recharge of applied water estimated to be 195,000 acre-feet per year. Annual urban and agricultural extractions are estimated at 24,000 and 648,000 acre-feet, respectively.

Land Use

Land use within the approximate 524,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-114.

Table 4-114. Land Use in the Tulare Lake Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	35,500
Field Crops	214,000
Grain and Hay	64,000
Pasture	55,500
Truck, Nursery, and Berry Crops	16,000
Vineyards	5,000
Total	**390,000**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the Tulare Lake Subbasin is the South San Joaquin Valley Water Quality Coalition.

Public water agencies in the Tulare Lake Groundwater Subbasin include: Alpaugh ID, Angiola WD, Atwell Island WD, Delano-Earlimart ID, Ducor ID, Kern-Tulare WD, Lower Tule River ID, Pixley ID, Porterville ID, Rag Gulch ID, Saucelito ID, Teapot Dome WD, Terra Bella ID, and Vandalia ID. California Water Service is the only identified private water agency within the subbasin.

The largest urban within the subbasin area is the City of Hanford with a population of approximately 46,350.

Pertinent Ordinances or Regulations

There are no known pertinent ordinances or regulations that affect groundwater in the Tulare Lake Subbasin.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR reports that between 1986 and 2003, 229 wells were sampled for pesticide residues in Kings County. Four of those wells had verified detections and 6 of the wells had unverified detections of atrizine, diuron, and/or prometon (Schuette et al. 2003). DWR (2003) reported detection of pesticides at concentration greater than an applicable MCL in groundwater collected from 2 of 40 wells sampled.

Various detections of selected compounds such as DBCP, xylenes, and ethyl dibromide were assumed to be the result of legal agricultural use prior to the Pesticide Contamination Prevention Act and therefore were not reviewed by the DPR.

Inorganic Constituents

Groundwater within the Tulare Lake Subbasin is generally a calcium bicarbonate type water in the northern portion that trends toward a sodium bicarbonate type water beneath Tulare Lakebed. Detected TDS concentrations typically range from 200 to 600 mg/L. TDS concentrations of shallow groundwater in areas of poor drainage are as high as 40,000 mg/L. DHS reported that detected TDS concentrations in groundwater collected from 36 wells (subject to Title 22 water quality standards) ranged from 150 to 820 mg/L, with an average of 342 mg/L. The city of Hanford reported EC values in groundwater from 14 wells ranged from 210 to 820 micromhos per centimeter (µmhos/cm), with an average value of 554 µmhos/cm (DWR 2003).

From 1994 to 2000, groundwater samples were collected from 38 wells within the subbasin for analysis of nitrates. Nitrates were not detected at a concentration above the MCL in any of the samples (DWR 2003).

There are areas of saline shallow groundwater in the southern portion of the subbasin and localized areas of high arsenic. The City of Hanford reported odors caused by the presence of hydrogen sulfide (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through water wells with an inadequate surface seal.

Groundwater flow is toward Tulare Lake bed with no known subsurface discharge from the subbasin (DWR 2003).

Kaweah Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Kaweah Subbasin is within the Tulare Lake HR and comprises an area of approximately 446,000 acres (696 mi^2) primarily in Tulare County with a small portion in Kings County (Figure 4-4). The Kaweah Subbasin is bounded on the north by the Kings Subbasin, on the south by the Tule Subbasin, and on the west by the Tulare Lake Subbasin, and on the east by crystalline bedrock of the Sierra Nevada foothills.

The Kaweah Subbasin aquifers are composed of unconsolidated sediments of Pliocene, Pleistocene, and Holocene age. On the east side of the subbasin, these deposits consist of arkosic material derived from the Sierra Nevada and are divided into three stratigraphic units: continental deposits, older alluvium, and younger alluvium. In the western portion of the subbasin unconsolidated deposits consisting of flood basin and lacustrine and marsh deposits interfinger with the eastside deposits.

The continental deposits of Pliocene and Pleistocene age are divided into oxidized and reduced deposits based on depositional environment. The oxidized deposits crop out along the eastern margin of the valley and consist of deeply weathered, poorly permeable, reddish-brown sandy silt and clay with well-developed soil profiles. The reduced deposits are moderately permeable and consist of micaceous sand, silt, and clay that extend to the west side of the valley in the subsurface.

Older alluvium, which overlies the continental deposits, is moderately to highly permeable and is the major aquifer in the subbasin. Younger alluvium consists of moderately to highly permeable arkosic sand and silty sand. Flood basin deposits consist of poorly permeable silt, clay, and fine sand. Groundwater in the flood basin deposits is often of poor quality. Lacustrine and marsh deposits consist of blue, green, or gray silty clay and fine sand and underlie the flood basin deposits. Clay beds of the lacustrine and marsh deposits form aquitards that control the vertical and lateral movement of groundwater. The most prominent lacustrine deposit is the Corcoran Clay that underlies the western half of the Kaweah Subbasin at depths ranging from about 200 to 500 feet (DWR 1981). The Corcoran Clay separates the lower confined from the upper unconfined aquifers where present. In the eastern portion of the subbasin (areas where the Corcoran Clay is absent), groundwater occurs under unconfined and semi-confined conditions (DWR 2003).

Major Sources of Recharge

The primary source of recharge to the area is seepage from streams flowing from the Sierra Nevada Mountains and percolation of applied irrigation water. Natural recharge is estimated to be 62,400 acre-feet per year. Lakeside Irrigation District has recharged about 7,000 acre-feet per year and in wet years may recharge up to 30,000 acre-feet. It is estimated that approximately 286,000 acre-feet of applied water is recharged annually in the subbasin. Annual urban and agricultural extraction is estimated to be 58,800 and 699,000 acre-feet, respectively (DWR 2003).

Groundwater flow is generally southwestward. Subsurface outflow may occur to the west and south towards the Tulare Lake Subbasin. DWR (2003) has not estimated the amount of inflow or outflow for the subbasin.

Land Use

Land use within the approximate 446,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-115.

Table 4-115. Land Use in the Kaweah Subbasin

Land Use	Approximate Acreage
Agriculture	
Citrus and Subtropical	77,000
Deciduous Fruits and Nuts	60,000
Field Crops	160,000
Grain and Hay	19,000
Pasture	57,500
Truck, Nursery, and Berry Crops	6,500
Vineyards	13,000
Total	**393,000**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the Kaweah Subbasin is the South San Joaquin Valley Water Quality Coalition.

Public water entities within the Kaweah Groundwater Subbasin include: Exeter ID, Ivanhoe ID, Kaweah-Delta WCD, Kings River Conservation District, Lakeside Irrigation Water District, Lindmore ID, Lindsay-Strathmore ID, St. Johns WD, Tulare ID, and Stone Corral WD. Private water entities within the subbasin include California Water Service, Melga Canal Company, Settlers Ditch Company, and Corcoran Irrigation Company.

Identified major urban areas are the City of Visalia with a population of approximately 92,500 and the City of Tulare with a population of approximately 49,500.

Pertinent Ordinances or Regulations

There are no known pertinent ordinances or regulations that affect groundwater in the Kaweah Subbasin.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR reports that from 1986 to 2003, groundwater samples were collected from 1,547 wells in Tulare County and 229 wells in Kings County and analyzed for pesticide residues. Groundwater samples from 365 of the wells had verified detections of pesticides and groundwater samples from 256 of the wells had unverified detection of pesticides in Tulare County. In Kings County, verified detections of pesticides were reported in samples collected from 4 well with unverified detection reported in samples collected from 6 wells. The detections in Tulare County were ACET, atrizine, bromacil, DACT, DEA, diuron, norflurazon, prometon, and simazine. Detections in Tulare County included atrazine, diuron, and prometon (Schuette et al. 2003). DWR reported that from 1994 to 2000, groundwater samples were collected from 167 well regulated by DHS and analyzed for pesticides. A pesticide was detected at a concentration greater than an applicable MCL in groundwater from 16 of the wells.

Various detections of selected compounds such as DBCP, xylenes, and ethyl dibromide were assumed to be the result of legal agricultural use prior to the Pesticide Contamination Prevention Act and therefore were not reviewed by the DPR.

Inorganic Constituents

Groundwater in the Kaweah Subbasin is typically a calcium bicarbonate type water, with sodium bicarbonate type water near the western margin of the subbasin. TDS ranges from 35 to 1,000 mg/L, with a typical range of 300 to 600 mg/L. The DHS reported TDS concentrations in groundwater collected from 153 wells, regulated by Title 22 standards, ranged from 35 to 580 mg/L, with an average concentration of 189 mg/L.

DWR (2003) reports that there are localized areas of high nitrate concentrations in groundwater on the eastern side of the subbasin and an area of high salinity groundwater between Lindsay and Exeter.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through water wells with an inadequate surface seal.

Groundwater may flow to the west into the Tulare Lake Subbasin. Groundwater flow can be in or out of the subbasin along the northern and southern boundaries, depending on conditions

Tule Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Tule Subbasin is within the Tulare Lake HR and comprises and area of approximately 467,000 acres (733 mi^2) in Tulare County (Figure 4-4). The subbasin is generally bordered on the north by the Kaweah Subbasin, on the south by the Kern Subbasin, on the west by the Tulare Lake Subbasin, and on the east by crystalline bedrock of the Sierra Nevada foothills.

The sediments that comprise the subbasin's aquifer are continental deposits of Tertiary and Quaternary age (Pliocene to Holocene). These deposits include flood basin deposits, younger alluvium, older alluvium, the Tulare Formation, and undifferentiated continental deposits.

- Flood basin deposits consist of relatively impermeable silt and clay interbedded with some moderately to poorly permeable sand layers that interfinger with the younger alluvium. These deposits are not an important source of water to wells, but may yield sufficient supplies for domestic and stock use.
- The younger alluvium consists of interstratified and discontinuous beds of unsorted to fairly well sorted clay, silt, sand, and gravel beneath the alluvial fans in the valley and stream channels. Where saturated, the younger alluvium is very permeable, but this unit is largely unsaturated and probably not important as a source of water.
- The older alluvium consists of poorly sorted deposits of clay, silt, sand, and gravel. This unit is moderately to highly permeable and is a major source of water to wells.
- The Tulare Formation consists of poorly sorted deposits of clay, silt, sand, and gravel derived predominately from the Coast Ranges. It contains the Corcoran Clay Member, a major confining bed in the subbasin. The formation is moderately to highly permeable and yields moderate to large quantities of water to wells.
- The undifferentiated continental deposits consist of poorly sorted lenticular deposits of clay, silt, sand, and gravel derived from the Sierra Nevada. The unit is moderately to highly permeable and is a major source of groundwater in the subbasin (DWR 2003).

Major Sources of Recharge

Groundwater recharge is primarily from stream recharge and from deep percolation of applied irrigation water (Hilton et al. 1963). The natural recharge into the subbasin is estimated at 34,400 acre-feet per year. Approximately 201,000 acre-feet of recharge from applied water occurs annually in the subbasin. Annual urban and agricultural extractions are estimated to be 19,300 and 641,000 acre-feet, respectively (DWR 2003). Groundwater flow is generally westward. Recharge to the confined aquifer below the Corcoran Clay occurs as subsurface flow from the east.

Land Use

Land use within the approximate 467,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-116.

Table 4-116. Land Use in the Tule Subbasin

Land Use	Approximate Acreage
Agriculture	
Citrus and Subtropical	36,500
Deciduous Fruits and Nuts	38,000
Field Crops	99,000
Grain and Hay	51,000
Pasture	60,500
Truck, Nursery, and Berry Crops	2,500
Vineyards	56,500
Total	**344,000**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the Tule Subbasin is the South San Joaquin Valley Water Quality Coalition.

Public water entities within the Tule Groundwater Sub basin include: Alpaugh ID, Angiloa WD, Atwell Island WD, Delano-Earlimart ID, Ducor ID, Kern-Tulare WD, Lower Tule River ID, Pixley ID, Porterville ID, Rag Gulch WD, Saucelito ID, Teapot Dome WD, Terra Bella ID, and Vandalia ID. California Water Service is the only identified private water entity within the subbasin.

The largest urban area in the subbasin is the City of Porterville with a population of approximately 44,500.

Pertinent Ordinances or Regulations

There are no known pertinent ordinances or regulations that affect groundwater in the Tule Subbasin.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR reports that from 1986 to 2003, that groundwater samples were collected from 1,547 wells in Tulare County for analysis of pesticide residues. Verified detections were reported in 365 of the wells sampled with unverified detection reported in samples from 256 of the wells. The detections included:

ACET, atrizine, bromacil, DACT, DEA, diuron, norflurazon, prometon, and simazine (Schuette et al. 2003). DWR (2003) reported that from 1994 to 2000, groundwater samples were collected from 73 wells regulated by the DHS. One of those wells contained groundwater with a verified pesticide above an applicable MCL.

Various detections of selected compounds such as DBCP, xylenes, and ethyl dibromide were assumed to be the result of legal agricultural use prior to the Pesticide Contamination Prevention Act and therefore were not reviewed by the DPR.

Inorganic Constituents

Groundwater beneath the northern portion of the subbasin is a calcium bicarbonate type water, while groundwater beneath the southern portion of the subbasin is typically a sodium bicarbonate type water. Detected TDS concentrations typically range from 200 to 600 mg/L. TDS concentrations of shallow groundwater in areas of poor drainage can be as high as 30,000 mg/L. The DHS, which monitors Title 22 water quality standards, reports TDS concentrations in groundwater from 65 wells from 1994 to 2000, ranged from 20 to 490 mg/L, with an average concentration of 256 mg/L. Saline shallow groundwater occurs in the western portion of the subbasin (DWR 2003).

DWR (2003) reports that the eastern side of the subbasin has localized nitrate pollution. Analysis of groundwater samples collected from 71 wells from 1994 to 2000, regulated by DHS, detected nitrates at concentrations above the MCL in six of the wells.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through water wells with an inadequate surface seal.

Groundwater flow is typically to the west. Subsurface groundwater may be to the west into the Tulare Lake Subbasin or southwest into the Kern Subbasin. Subsurface groundwater flow can be in or out of the subbasin along the northern and southern boundaries, depending on conditions.

Kern County Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Kern County Subbasin is within the Tulare Lake HR and comprises and area of approximately 1,945,000 acres (3,040 mi^2) in Kern County. The subbasin is bounded to the north by the Tulare Lake and Tule Subbasin, to the east and south by crystalline bedrock of the Sierra Nevada and San Emigdio Mountains, and to the west by the marine sediments of the San Emigdio Mountains and Coast Ranges.

The shallow to intermediate depth water-bearing units in the subbasin are primarily continental deposits of Tertiary and Quaternary age. From oldest to youngest the deposits include: the Olcese and Santa Margarita Formations, the Tulare Formation (western portion of the subbasin) and laterally equivalent Kern River Formation (eastern portion of the subbasin), older alluvium, and younger alluvium and laterally equivalent flood basin deposits (DWR 2003).

The origin of the Miocene Olcese and Santa Margarita Formations varies from continental to marine from east to west across the subbasin. The Olcese and Santa Margarita Formations are current sources of drinking water only in the northeastern portion of the sub basin where they occur as confined aquifers. The Olcese Formation is primarily sand, ranging in thickness from 100 to 450 feet. The Santa Margarita Formation is from 200 to 600 feet thick and consists of coarse-grained sand (DWR 2003).

The Tulare and Kern River Formations are both Plio-Pleistocene age and represent a west/east facies change across the subbasin. The Tulare Formation (western subbasin) contains up to 2,200 feet of interbedded, oxidized to reduced sands; gypsiferous clays and gravels derived primarily from Coast Range sources. The formation includes the Corcoran Clay, which is present in the subsurface from the Kern River Outlet Channel on the west through the central and much of the eastern subbasin at depths of 300 to 650 feet. Groundwater beneath the Corcoran Clay is confined. The Kern River Formation includes from 500 to 2,000 feet of poorly sorted, lenticular deposits of clay, silt, sand, and gravel derived from the Sierra Nevada. Both units are moderately to highly permeable and yield moderate to large quantities of water to wells (DWR 2003).

The older alluvium and Terrace Deposits are composed of up to 250 feet of Pleistocene-age lenticular deposits of clay, silt, sand, and gravel that are loosely consolidated to cemented and are exposed mainly at the subbasin margins. The unit is moderately to highly permeable and yields large quantities of water to wells. This sedimentary unit is often indistinguishable from the Tulare and Kern

River Formations below and together with these underlying formations, forms the principal aquifer in the Kern County Subbasin (DWR 2003).

The Holocene-age younger alluvium and flood basin deposits vary in character and thickness in the subbasin. Along the eastern and southern subbasin margins, the unit consists of up to 150 feet of interstratified and discontinuous beds of clay, silt, sand, and gravel. In the southwestern portion of the subbasin is the unit is finer grained and less permeable as it grades into fine-grained flood basin deposits underlying the historic lakebeds of Buena Vista and Kern Lakes in the southern portion of the subbasin. The flood basin deposits consist of silt, silty clay, sandy clay, and clay interbedded with poorly permeable sand layers. These flood basin deposits are difficult to distinguish from underlying fine-grained older alluvium and the total thickness of both units may be as much as 1,000 feet (DWR 2003).

Faults that affect groundwater movement include the Edison, Pond-Poso, and White Wolf faults. Other barriers to groundwater movement include anticlinal folds such as Elk Hills and Buena Vista Hills, angular unconformities, and contacts with crystalline and consolidated sedimentary rocks at the subbasin margins. The Corcoran Clay significantly impedes vertical groundwater movement where present (DWR 2003).

Major Sources of Recharge

Applied irrigation water is the largest source of recharge in the subbasin with natural recharge occurring primarily from stream seepage along the eastern margin of the subbasin and the Kern River (DWR 2003).

Water banking was initiated in the subbasin in 1978, and as of 2000, seven projects contain over 3 maf of banked water in a combined potential storage volume of 3.9 maf (KCWA 2001). Approximately two-thirds of this storage is in the Kern River Fan area west of Bakersfield with the remainder in the Arvin-Edison WSD in the southeastern portion of the subbasin and in the Semitropic WSD in the northwestern part of the subbasin.

Land Use

Land use within the approximately 1,945,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-117.

Table 4-117. Land Use in the Kern County Subbasin

Land Use	Approximate Acreage
Agriculture	
Citrus and Subtropical	56,000
Deciduous Fruits and Nuts	198,500
Field Crops	350,500
Grain and Hay	130,500
Pasture	125,000
Truck, Nursery, and Berry Crops	91,500
Vineyards	115,500
Total	**1,067,500**

Coalitions, Water Districts, Major Urban Areas

The only identified water quality coalition within the Kern Subbasin is the South San Joaquin Valley Water Quality Coalition.

Public water entities within the Kern County Groundwater Subbasin include: Kern County Water Agency, City of Bakersfield, West Kern Water Agency, and the Buena Vista Water agency. Private water entities within the sub basin include: California Water Service Company, McFarland Mutual Water Company, Stockdale Mutual Water Company, and numerous small community groups.

The City of Bakersfield is the only identified major urban area within the subbasin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a Conditional Use Permit (CUP) by Kern County to transport native groundwater outside of Kern County and it’s watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR reports that from 1986 to 2003, groundwater samples were collected from 1,341 wells in Kern County for analysis of pesticide residues. Verified detections were reported in 22 of the wells sampled; however there were 206 unverified detections. The verified detections included ACET, atrizine, bromacil, DACT, DEA, diuron, and simazine (Schuette et al. 2003). From 1994 to 2000, 436 groundwater samples were collected from wells regulated by DHS in Kern County. Analysis of groundwater from 23 of the wells detected at least one pesticide at a concentration greater than an applicable MCL (DWR 2003).

Various detections of selected compounds such as DBCP, xylenes, and ethyl dibromide were assumed to be the result of legal agricultural use prior to the Pesticide Contamination Prevention Act and therefore were not reviewed by the DPR.

Inorganic Constituents

Groundwater beneath the eastern portion of the Kern Subbasin contains primarily calcium bicarbonate type water in the shallow zones with the sodium content increasing with depth. In western parts of the subbasin bicarbonate is replaced by sulfate and lesser chloride. The average TDS concentration of groundwater is 400 to 450 mg/L with a range of 150 to 5,000 mg/L (DWR 2003).

Shallow groundwater near the trough of the valley has high TDS, sodium, chloride, and sulfate concentrations. Elevated arsenic concentrations exist in some areas associated with lakebed deposits. Nitrate, DBCP, and ethyl dibromide have been detected at concentrations exceeding MCLs in various areas of the basin. Groundwater samples for analysis of nitrates were collected between 1994 and 2000 from 475 wells in Kern County. Nitrates were detected at concentrations greater than the MCL in groundwater from 38 of the wells (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through water wells with an inadequate surface seal.

Pleasant Valley Subbasin

General subbasin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General subbasin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Pleasant Valley Groundwater Subbasin is within the Tulare Lake HR and comprises an area of approximately 146,000 acres (227 mi^2) in the western portion of Kings and Fresno Counties (Figure 4-4). The subbasin lies on the western edge of the San Joaquin Valley and is mostly surrounded by uplifted areas of the Coast Ranges and Kettleman Hills. The subbasin is bounded by the Westside Subbasin to the northeast, Tulare Lake Subbasin to the east, and Kern County Subbasin to the south.

Water-bearing units within the subbasin include Holocene alluvium, the Plio-Pleistocene Tulare Formation, and the Pliocene San Joaquin Formation. Holocene alluvium consists of lenticular deposits of poorly sorted clay, silt, and sand. It is believed that the thickness of this unit does not exceed 300 feet (DWR 2003).

The Plio-Pleistocene Tulare Formation unconformably underlies Holocene alluvium. The Tulare Formation comprises the youngest folded sediments exposed in the Kettleman Hills. In the Kettleman Hills, where the unit is exposed, it consists primarily of continental deposits of sandstone and conglomerate. DWR (2003) reports that the Tulare Formation in the subbasin consists of highly lenticular deposits of poorly sorted clay, silt, and sand with occasional interbeds of well-sorted fine- to medium-grained sand.

The Pliocene San Joaquin Formation consists of alternating beds of clay, silt, sand, and conglomerate. The sand and conglomerate beds contain fossils indicative of deposition in marine to non-marine conditions.

Major Sources of Recharge

Groundwater recharge is primary from seepage from the various streams that cross the subbasin. The cities of Coalinga, in the northern portion of the subbasin, and Avenal, near the center import water for municipal purposes. The state prisons near Coalinga and Avenal also use imported water. Additional recharge may occur as a consequence of this water use. It is estimated that approximately 4,000 acre-feet per year of applied water is recharged within the subbasin (DWR 2003). No data were found concerning the amount of natural recharge within the subbasin.

Land Use

Land use within the approximately 146,000-acre subbasin is primarily agricultural (Figure 4-6). Primary crops grown and approximate acreages within the subbasin, as identified by the land use maps, are listed in Table 4-118.

Table 4-118. Land Use in the Pleasant Valley Subbasin

Land Use	Approximate Acreage
Agriculture	
Deciduous Fruits and Nuts	2,000
Field Crops	14,500
Grain and Hay	30,500
Pasture	5,000
Truck, Nursery, and Berry Crops	10,500
Total	**62,500**

Coalitions, Water Districts, Major Urban Areas

There are no known water quality coalitions operating within the Pleasant Valley Subbasin.

Public water entities within the Pleasant Valley Groundwater Sub basin include: Pleasant Valley WD, City of Coalinga, Devil's Den WD, and Green Valley WD. There are no identified private water entities within the sub basin.

The largest developed area in the subbasin is Coalinga with a population of approximately 17,000.

Pertinent Ordinances or Regulations

Fresno County has a Groundwater Management Ordinance restricting the extraction and transfer of groundwater outside of the County. The ordinance states:

> The protection of the health, welfare, and safety of residents of the county, and the public benefit of the state, require that groundwater resources of Fresno County be protected from harm resulting from the extraction and transfer of groundwater for use on lands outside the county, and from harm resulting from the extraction of groundwater for use on lands within the county to substitute for the consequential transfer of surface water outside of the county, until such time as needed additional surface water supplies are obtained for use on lands of the county, or overdrafting is alleviated.

A County-issued permit is required for groundwater transfer, directly or indirectly, outside of the County, unless the action is exempted or a permit first obtained.

No known pertinent groundwater ordinances have been adopted by Kings County.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

The DPR (Schuette et al. 2003) reported that between 1986 and 2003, 4,032 wells were sampled for pesticide residues in Fresno County and 229 wells in Kings County. Fresno County had 224 wells with verified detections and 369 wells with unverified detections while Kings County reported 4 wells with verified detections and 6 wells with unverified detections. Groundwater detections in Fresno County included: ACET, atrizine, bromacil, DACT, DEA, diuron, norflurazon, prometon, and simazine. Groundwater detections in Kings County included: atrizine, diuron, and prometon.

Inorganic Constituents

TDS concentrations of groundwater in Pleasant Valley WD ranged from 1,000 to 3,000 mg/L with an average of 1,500 mg/L. The constituents in groundwater include calcium, magnesium, sodium, bicarbonates, chlorides, sulfates, and boron. The high TDS concentrations limit the usability of groundwater in the subbasin for most uses (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants in the subbasin is from deep percolation of water through the overlying sediments to the groundwater table or through water wells with an inadequate surface seal. No data were obtained regarding discharge pathways from the subbasin.

Small Groundwater Basins

Panoche Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Panoche Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 33,184 acres (52 square miles), in San Benito County (Figure 4-4). Panoche Valley is an elongate northwest-southeast trending basin in the Coast Range Mountains.

No specific published information on the water-bearing units of the basin were identified. Limited well log information indicates that drilling in the basin has encountered gravels, sands, silts, and clays. These deposits are believed to be recent alluvium, Quaternary nonmarine terrace deposits, and Plio-Pleistocene nonmarine sediments (DWR 2003).

Major Sources of Recharge

Information regarding recharge of groundwater was not identified. However, groundwater levels have generally risen over 40 feet throughout the basin since the 1970s. The rise in water levels is believed to be due to recovery from past periods of pumping for agricultural uses (DWR 2003). Groundwater recharge in the basin probably occurs from percolation of precipitation and infiltration from ephemeral streams in the area.

Land Uses

Land use within the approximately 33,84-acre basin is shown on Figure 4-6. According to land use data, approximately 44 acres are planted to deciduous fruits and nuts with an additional 62 acres being used for activities that are semiagricultural or incidental to agriculture (Table 4-119). DWR (2003) indicates that extensive areas of alfalfa and cotton were cultivated in the 1950s and 1960s, but a reconnaissance of the basin in 2001 identified one vineyard of less than 20 acres and one walnut orchard of less than 20 acres as the only irrigated agriculture within the basin.

Table 4-119. Land Use in the Panoche Valley Groundwater Basin

Land Use	Acreage of Land Use	Percent of Land Use
Agriculture		
Deciduous Fruits and Nuts	44	0.13
Grain and Hay	7,948	24.02
Vineyards	27	0.08
Truck, Nursery, and Berry Crops	9	0.03
Semiagricultural and Incidental	62	0.19
Subtotal	8,090	24.45
Native		
Native Vegetation	24,994	75.55
Subtotal	24,994	75.55
Total	**33,084**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions or public water entities in the Panoche Valley Groundwater Basin. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

No ordinances or regulations regarding groundwater were identified in San Benito County.

Water Quality

Data were available for groundwater samples collected from 26 wells between 1954 and 1988. TDS values for these samples ranged from 394 to 3,530 mg/L (DWR 2003). No analytical data for analysis of pesticides or nitrates in groundwater were identified.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Kern River Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Kern River Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 79,432 acres (124 square miles), in Kern County (Figure 4-4). The basin is irregularly shaped reflecting the shape of the Kern River drainage in the southern Sierra Nevada Mountains.

Water-bearing units in the basin consist primarily of recent alluvium and to a lesser extent older alluvium. The alluvium is derived from surrounding granitic and metamorphic rocks. The highest producing wells are located near the valley axis and near Lake Isabella (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to be percolation of precipitation along the valley margins and infiltration from flow in the north and south forks of the Kern River and their tributaries (DWR 2003).

Land Uses

Land use within the approximately 79,432-acre basin is shown on Figure 4-6. According to land use data, approximately 4,549 acres are agricultural with about 97 acres in semiagricultural or incidental to agriculture land uses (Table 4-120).

Table 4-120. Land Use in the Kern River Valley Groundwater Basin

DWR Land Use	Acreage of Land Use	Percent of Land Use
Agriculture		
Deciduous Fruits and Nuts	7	0.01
Grain and Hay	777	0.98
Pasture	2,931	3.69
Truck, Nursery, and Berry Crops	693	0.87
Idle	44	0.06
Semiagricultural and Incidental	97	0.12
Subtotal	4,549	5.73
Urban		
Urban—unclassified	2,256	2.84
Urban Landscape	75	0.09
Urban Residential	2,342	2.95
Commercial	137	0.17
Industrial	57	0.07
Vacant	122	0.15
Subtotal	4,988	6.28
Native		
Native Vegetation	33,939	42.73
Riparian	3,008	3.79
Water	10,644	13.40
Subtotal	47,591	59.91
FRAP Land Use Type		
Barren	78	0.10
Conifer	247	0.31
Hardwood	1,770	2.23
Herbaceous	2,205	2.78
Shrub	7,527	9.48
Urban	375	0.47
Desert	10,103	12.72
Subtotal	22,304	28.08
Total	**79,432**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions in the Kern River Valley Groundwater Basin. There are no identified public water entities in the basin and private water entities include Kern River Valley Water Company, Erskine Creek Water Company, James Water System, and Mountain Mesa Water Company. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it's watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 58 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Based on samples from 11 wells, TDS values range from 253 to 480 mg/L with an average of 378 mg/L. Iron and manganese have been detected at concentrations above the applicable secondary MCL in samples collected from wells along the Kern Canyon Fault. Nitrates were detected at concentration exceeding the MCL in samples collected from 5 of 76 wells sampled from 1994 to 2000 (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Walker Basin Creek Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Walker Basin Creek Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 7,644 acres (12 square miles), in Kern County (Figure 4-4). The basin is a shallow alluvial basin in the southern Sierra Nevada Mountains.

The basin fill consists of alluvial sediments up to 150 feet thick with an average thickness of approximately 70 feet. A limited number of well logs in the basin identify decomposed granitic rock, sand, clay, and minor gravel (DWR 2003).

Major Sources of Recharge

Groundwater recharge appears to occur by percolation of precipitation and infiltration from ephemeral and spring-fed perennial streams entering the basin (DWR 2003).

Land Uses

Land use within the approximately 7,644-acre basin is shown on Figure 4-6. According to land use data, approximately 1,347 acres are agricultural with another 17 acres in uses that are semiagricultural or incidental to agriculture (Table 4-121).

Table 4-121. Land Use in the Walker Basin Creek Valley Groundwater Basin

Land Use	Acreage of Land Use	Percent of Land Use
Agriculture		
Deciduous Fruits and Nuts	39	0.51
Field Crops	111	1.46
Grain and Hay	214	2.80
Pasture	799	10.45
Truck, Nursery, and Berry Crops	168	2.19
Semiagricultural and Incidental	17	0.22
Subtotal	1,347	17.62
Urban		
Urban Residential	381	4.98
Subtotal	381	4.98
Native		
Native Vegetation	5,917	77.40
Water	23	0.30
Subtotal	5,917	77.40
Total	**7,644**	**100**

Coalitions, Water Districts, Major Urban Areas,

There are no identified water quality coalitions, public water entities, or private water entities in the Walker Basin Creek Valley Groundwater Basin. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it's watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

No data were identified describing groundwater quality in the basin.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Cummings Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Cummings Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 10,019 acres (16 square miles), in Kern County (Figure 4-4). The basin is bounded on the north by the Sierra Nevada Mountains and on the south by the Tehachapi Mountains. Ridges on the east and west side of the basin connect the mountain ranges.

Water-bearing units in the basin consist of alluvium deposited in alluvial fans and on floodplains. The alluvial deposits are up to 450 feet thick with sands and gravels on the edge of the basin becoming finer grained towards the center of the basin (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to be percolation of precipitation and infiltration from ephemeral streams along the margins of the basin. Thick clays in the center of the basin restrict infiltration on the valley floor (DWR 2003).

Land Uses

Land use within the approximately 10,019-acre basin is shown on Figure 4-6. According to land use data, approximately 2,667 acres are agricultural with about 119 acres in uses that are semiagricultural or incidental to agriculture (Table 4-122).

Table 4-122. Land Use in the Cummings Valley Groundwater Basin

DWR Land Use Type	Acreage of Land Use	Percent of Land Use
Agriculture		
Deciduous Fruits and Nuts	93	0.92
Grain and Hay Crops	334	3.33
Field Crops	508	5.07
Pasture	1,165	11.63
Semiagricultural and Incidental	119	1.19
Truck, Nursery, and Berry Crops	448	4.48
Subtotal	2,667	26.62
Urban		
Urban—unclassified	25	0.25
Urban Residential	723	7.22
Commercial	214	2.13
Industrial	8	0.08
Vacant	4	0.04
Subtotal	974	9.72
Native		
Native Vegetation	6,333	63.21
Water Surface	46	0.46
Subtotal	6,379	63.66
Total	**10,019**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions in the Cummings Valley Groundwater Basin. The groundwater basin is adjudicated and the Tehachapi-Cummings County Water District (TCCWD) is the watermaster. The only identified public water entity is the TCCWD with private water entities including the Stallion Springs Community Services District and the Bear Valley Community Services District. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it’s watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 15 wells in the basin from 1994 to 2000 for analysis of pesticides. There was one detection of a pesticide at a concentration above an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Groundwater in the basin is primarily a calcium-bicarbonate type with an average TDS of 344 mg/L. Analysis of groundwater samples collected from 15 wells from 1994 to 2000 did not detect nitrates at a concentration exceeding the MCL (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Tehachapi Valley West Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Tehachapi Valley West Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 14,908 acres (23 square miles), in Kern County (Figure 4-4). The basin lies in the western half of Tehachapi Valley and is bounded on the north by the Sierra Nevada Mountains and on the south by the Tehachapi Mountains.

Quaternary alluvium, up to 600 feet thick, is the primary water-bearing unit in the basin (DWR 2003). Lithologic descriptions of the Quaternary alluvium were not available.

Major Sources of Recharge

Groundwater recharge in the basin consists of percolation of stream flow within the basin and to a lesser extent percolation of precipitation (DWR 2003).

Land Uses

Land use within the approximately 14,908-acre basin is shown on Figure 4-6. According to land use data, approximately 1,143 acres are used for agricultural activities with about 36 acres in uses semiagricultural or incidental to agriculture (Table 4-123).

Table 4-123. Land Use in the Tehachapi Valley West Groundwater Basin

DWR Land Use Type	Acreage of Land Use	Percent of Land Use
Agriculture		
Deciduous Fruits and Nuts	322	2.16
Grain and Hay Crops	403	2.70
Pasture	45	0.30
Field Crops	284	1.90
Semiagricultural and Incidental	36	0.24
Truck, Nursery, and Berry Crops	52	0.35
Subtotal	1,143	7.66
Urban		
Urban—unclassified	1,040	6.97
Urban Residential	3,071	20.60
Urban Landscape	52	0.35
Vacant	212	1.42
Subtotal	4,375	29.35
Native		
Native Vegetation	9,194	61.67
Water Surface	92	0.62
Subtotal	9,286	62.29
Total	**14,908**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions in the Cuddy Canyon Valley Groundwater Basin. The Tehachapi Valley West Groundwater Basin is an adjudicated basin. The TCCWD is the watermaster. Identified public water entities within the basin include TCCWD, City of Tehachapi, and Golden Hills Community Services District. The only identified private water entity in the basin is the Ashtown Mutual Water System. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it’s watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 23 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Based on data from 3 wells, TDS values ranged from 280 to 365 mg/L. Groundwater samples were collected from 30 wells in the basin from 1994 to 2000 for analysis of nitrates. Nitrates were detected at concentrations exceeding the MCL in samples collected from two of the wells (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Castaic Lake Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Castaic Lake Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 3,566 acres (6 square miles), in Kern County (Figure 4-4). Castaic Lake Valley is a “Y” shaped basin formed by the Garlock Fault and Grapevine Creek in the Tehachapi Mountains. Castaic Lake is a sag pond along the Garlock Fault (DWR 2003).

No data were found describing the water-bearing materials in the basin. Castaic Lake is a Quaternary playa where deposits typically consist of silts and clays that yield little water (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to be percolation of precipitation and infiltration from flow in Cuddy Creek and other ephemeral and spring-fed perennial streams that flow into the basin (DWR 2003).

Land Uses

Land use within the approximately 3,566-acre basin is shown on Figure 4-6. According to land use data, approximately 232 acres are used as pasture with no other identified agricultural uses in the basin (Table 4-124).

Table 4-124. Land Use in the Castaic Lake Valley Groundwater Basin

DWR Land Use Type	Acreage of Land Use	Percent of Land Use
Urban		
Urban—unclassified	47	1.30
Vacant	2	0.07
Subtotal	49	1.37
Native		
Native Vegetation	60	1.68
Subtotal	60	1.68
FRAP Land Use Type		
Barren	26	0.72
Conifer	30	0.84
Hardwood	664	18.62
Herbaceous	1,012	28.38
Shrub	363	10.18
Urban	568	15.93
Pasture	232	6.51
Water	312	8.75
Wetland	206	5.78
Desert	44	1.23
Subtotal	3,457	96.95
Total	**3,566**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions or private water entities in the Castaic Lake Valley Groundwater Basin. The only identified public water entities within the basin are the Tejon-Castaic Water District and Lebec County Water District. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it’s watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 6 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Measured TDS values for samples collected from three wells ranged from 570 to 605 mg/L. Groundwater samples were collected from 8 wells in the basin from 1994 to 2000 for nitrate analyses. Nitrates were not detected at a concentration exceeding the MCL in the samples analyzed. The only reported impairment to water quality was a detection of fluoride above the MCL in one well (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Vallecitos Creek Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Vallecitos Creek Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 15,107 acres (24 square miles), in San

Benito County (Figure 4-4). The basin is a northwest-southeast trending synclinal valley within the Coast Range Mountains.

Very limited information was identified regarding the water-bearing units in the basin. The valley reportedly contains Quaternary alluvium surrounded by Plio-Pleistocene nonmarine sediments and Miocene to Paleocene marine sediments. It is likely that water-bearing materials are restricted to shallow alluvium in the center of the valley (DWR 2003).

Major Sources of Recharge

Information regarding recharge of groundwater was not identified. Groundwater recharge in the basin probably occurs from percolation of precipitation and infiltration from ephemeral streams in the area.

Land Uses

Land use within the approximately 15,107-acre basin is shown on Figure 4-6. According to land use data, there are no agricultural land uses in the basin (Table 4-125).

Table 4-125. Land Use in the Vallecitos Creek Valley Groundwater Basin

DWR Land Use Type	Acreage of Land Use	Percent of Land Use
Native		
Native Vegetation	15,107	100
Total	**15,107**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions or water entities in the Vallecitos Creek Valley Groundwater Basin. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

No ordinances or regulations regarding groundwater were identified in San Benito County.

Water Quality

No water quality data were identified within the basin.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Brite Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Brite Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 3,170 acres (5 square miles), in Kern County (Figure 4-4). The basin is a northwest to southeast trending valley bounded on the north by the Sierra Nevada Mountains and on the south by the Tehachapi Mountains. The basin is separated from Cummings Valley Groundwater Basin to the west and Tehachapi Valley West Groundwater Basin to the east by low lying ridges.

The primary water-bearing unit in the basin is alluvium deposited in alluvial fans on the edges of the valley and on floodplains in the center of the valley. The alluvium has a maximum thickness of approximately 500 feet (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to be percolation of precipitation and infiltration from flow in Brite Creek and other ephemeral streams in the valley. The TCCWD owns and operates a storage and recharge facility for water received from the State Project Water (DWR 2003).

Land Uses

Land use within the approximately 3,170-acre basin is shown on Figure 4-6. According to land use data, approximately 282 acres in the basin are used for agricultural purposes with another 26 acres in uses semiagricultural or incidental to agriculture (Table 4-126).

Table 4-126. Land Use in the Brite Valley Groundwater Basin

DWR Land Use Type	Acreage of Land Use	Percent of Land Use
Agriculture		
Deciduous Fruits and Nuts	174	5.49
Grain and Hay Crops	69	2.17
Pasture	19	0.60
Vineyards	5	0.17
Semiagricultural and Incidental	26	0.82
Truck, Nursery, and Berry Crops	14	0.46
Subtotal	308	9.70
Urban		
Urban Residential	132	4.18
Commercial	72	2.27
Subtotal	205	6.45
Native		
Native Vegetation	2,610	82.32
Water Surface	48	1.53
Subtotal	2,658	83.84
Total	**3,170**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions in the Cuddy Canyon Valley Groundwater Basin. Brite Valley Groundwater Basin is an adjudicated basin. The TCCWD is the watermaster. The only identified public or private water entity within the basin is the TCCWD. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it's watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Groundwater within the basin appears to be a calcium-bicarbonate type water with an electrical conductivity range from 550 to 770 micromohs per centimeter.

No groundwater analytical data for pesticides or nitrates were identified from within the Brite Valley Groundwater Basin.

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Cuddy Canyon Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Cuddy Canyon Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 3,299 acres (5 square miles), in Kern County (Figure 4-4). The basin is within the San Emigdio Mountains in a series of valleys formed along the San Andreas Fault.

Water-bearing units in the basin consist of recent and older alluvium deposited in the Cuddy Creek drainage. These deposits consist of poorly sorted silty sand and gravel (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to be percolation of precipitation and infiltration from flow in Cuddy Creek and other ephemeral streams in the valley (DWR 2003).

Land Uses

Land use within the approximately 3,299-acre basin is shown on Figure 4-6. According to land use data, approximately 7 acres are used as pasture with no other identified agricultural uses in the basin (Table 4-127).

Table 4-127. Land Use in the Cuddy Canyon Valley Groundwater Basin

FRAP Land Use Type	Acreage of Land Use	Percent of Land Use
Agriculture	7.413	0.22
Barren	270	8.17
Conifer	427	12.94
Hardwood	51	1.54
Herbaceous	379.2	11.49
Shrub	1,564	47.39
Urban	602	18.24
Desert	0.091	0.003
Total	**3,299**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions in the Cuddy Canyon Valley Groundwater Basin. The only identified public entity within the basin is the Frazier Park Public Utility District. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it’s watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 5 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Groundwater quality in the basin has not been characterized by DWR. Measured TDS values for samples collected from two wells ranged from 690 to 695 mg/L. Groundwater samples were collected from 5 wells in the basin for nitrate analyses from 1994 to 2000. Nitrates were not detected at a concentration exceeding the MCL in the samples analyzed. The only identified detections above an applicable MCL in the basin include fluoride and radiological constituents (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Cuddy Ranch Area Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Cuddy Ranch Area Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 4,186 acres (7 square miles), in Kern County (Figure 4-4). The basin is within the San Emigdio Mountains in a series of valleys formed along the San Andreas Fault.

Deposits in the basin include sandstone, conglomerate, siltstone, and claystone on the Tertiary Caliente Formation. The Tertiary deposits are overlain by Pleistocene and recent alluvium composed of unconsolidated gravels, sands, and silts. Abundant clays in the south end of the basin suggest the presence of lacustrine and/or marsh deposits that may indicate the basin was recently closed (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to occur by percolation of precipitation and infiltration from ephemeral streams in the area (DWR 2003).

Land Uses

Land use within the approximately 4,186-acre basin is shown on Figure 4-6. According to land use data, approximately 290 acres are used as pasture with no other identified agricultural uses in the basin (Table 4-128).

Table 4-128. Land Use in the Cuddy Ranch Area Groundwater Basin

DWR Land Use Type	Acreage of Land Use	Percent of Land Use
Agriculture		
Pasture	290	6.92
Subtotal	290	6.92
Urban		
Urban—unclassified	17	0.41
Subtotal	17	0.41
Native		
Native Vegetation	3,262	77.93
Subtotal	3,262	77.93
FRAP Land Use Type		
Conifer	267	6.37
Herbaceous	30	0.72
Shrub	102	2.44
Urban	218	5.21
Subtotal	617	14.73
Total	**4,186**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions, public water entities, or private water entities in the Cuddy Ranch Area Groundwater Basin. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it’s watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 5 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

The measured TDS of groundwater in the basin ranges from 690 to 695 mg/L. Groundwater samples were collected from 6 wells in the basin for nitrate analyses from 1994 to 2000. Nitrates were not detected at a concentration exceeding the MCL in the samples analyzed (DWR 2003).

Discharge Pathways and Sources of Contaminants

The most likely pathway of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Cuddy Valley Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Cuddy Valley Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 3,465 acres (5 square miles), in Kern County (Figure 4-4). The valley is an elongate east-west trending valley in the San Emigdio Mountains.

Water-bearing units in the basin consist of older alluvial and terrace deposits and younger alluvium. These deposits have a maximum thickness of approximately 450 feet and are underlain by crystalline bedrock or undifferentiated Tertiary sediments (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to occur primarily by percolation of precipitation. Recharge from septic systems in the Pinion Pines and Pineridge developments supplements the natural recharge (DWR 2003).

Land Uses

Land use within the approximately 3,465-acre basin is shown on Figure 4-6. According to land use data, there are no identified agricultural uses in the basin (Table 4-129).

Table 4-129. Land Use in the Cuddy Valley Groundwater Basin

FRAP Land Use Type	Acreage of Land Use	Percent of Land Use
Conifer	1,615	46.62
Hardwood	10.3	0.30
Herbaceous	917	26.46
Shrub	714	20.61
Urban	199	5.73
Water	9.9	0.29
Total	**3,465**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions, public water entities, or private water entities in the Cuddy Valley Groundwater Basin. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a CUP by Kern County to transport native groundwater outside of Kern County and it's watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 5 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Groundwater quality in the basin has not been characterized by DWR. TDS values in the basin range from 325 to 645 mg/L. Groundwater quality appears to be better in the western portion of the basin with high levels of iron and manganese in samples collected from wells in the eastern portion of the basin. Groundwater samples were collected from 10 wells in the basin for nitrate analyses from 1994 to 2000. Nitrates were not detected at a concentration exceeding the MCL in the samples analyzed (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.

Mil Portero Area Groundwater Basin

General basin parameters, water quality, and discharge pathways and sources of contaminants are discussed below.

General Basin Parameters

General basin parameters of acreage and physiography; major sources of recharge; land use; coalitions, waters districts, and major urban areas; and pertinent ordinances and regulations are discussed below.

Acreage, Physiography, and Water-Bearing Units

The Mil Portero Groundwater Basin is within the Tulare Lake HR and comprises an area of approximately 2,309 acres (4 square miles), in Kern County (Figure 4-4). The basin is irregularly shaped and within the San Emigdio Mountains.

The basin consists of stream-derived alluvium and mudflow debris with a maximum thickness estimated at 400 feet. This material is underlain by the Tertiary Caliente Formation that is composed of sandstone, conglomerate, siltstone, and claystone (DWR 2003).

Major Sources of Recharge

Groundwater recharge in the basin appears to be percolation of precipitation and springs emanating from canyon walls on the south side of the basin. Natural recharge is supplemented by over 1,900 septic systems in the basin (DWR 2003).

Land Uses

Land use within the approximately 2,309-acre basin is shown on Figure 4-6. According to land use data, there are no agricultural land uses within the basin (Table 4-130).

Table 4-130. Land Use in the Mil Portero Area Groundwater Basin

FRAP Land Use Type	Acreage of Land Use	Percent of Land Use
Conifer	1,325	57.37
Herbaceous	61	2.65
Shrub	98	4.26
Urban	825	35.72
Total	**2,309**	**100**

Coalitions, Water Districts, Major Urban Areas

There are no identified water quality coalitions or public water entities in the Mil Portero Groundwater Basin. The only identified private water entity within the basin is the Mil Portero Mutual Water Company. There are no major urban areas in the basin.

Pertinent Ordinances or Regulations

Kern County has adopted Ordinance number G-6502 requiring the issuance of a Conditional Use Permit (CUP) by Kern County to transport native groundwater outside of Kern County and it's watersheds, including those through joint water conveyance facilities and sales to owners of water conveyance facilities. Four exemptions apply where a CUP is not required provided conditions of the Ordinance Code of Kern County are met.

Water Quality

Water quality relating to pesticide and inorganic constituents is discussed below.

Pesticides

Groundwater samples were collected from 6 wells in the basin from 1994 to 2000 for analysis of pesticides. Pesticides were not detected at a concentration that exceeded an applicable MCL in the samples analyzed (DWR 2003).

Inorganic Constituents

Measured TDS values for samples collected from wells in the basin range from 372 to 657 mg/L. Secondary water standards for aluminum, iron, and manganese are exceeded in the water supply of the Mil Portero Mutual Water Company. Groundwater samples were collected from 7 wells for nitrate analyses in the basin. Nitrates were not detected at a concentration exceeding the MCL in the samples analyzed (DWR 2003).

Discharge Pathways and Sources of Contaminants

The primary source of contaminants to groundwater is the percolation of water through the overlying sediments or through water wells that have an improperly constructed annular seal.